ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Vol. XXVIII. No. 44.

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Railways, Electric Railways, Elevated and Cable Railways, Horse and Motor Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Irrigation, Sewers, Streets, Electrical, Contract Prices, Miscellaneous, Manufacturing and Technical, Current Price List.

Sewer construction at Orange, N. J., under the contract with the Empire Construction Co. has been resumed. A few weeks ago the contractors claimed extra compensation on account of difficulties in construction which they said were not set forth in the information upon which their bid was based. After much negotiation the city has agreed to advance the contract price by 33⅓%, the Mayor having just signed the new contract. More information regarding this controversy was given in our issue of Aug. 25, 1892.

Specifications for a new water supply for Jersey City have been proposed by Mr. W. W. Ruggles, Chief Engineer of the Board of Street and Water Commissioners. A minimum supply of 22,000,000 gallons per day will be required, and the city may call for 35,000,000 gallons. The bids will be on the basis of price per million gallons for furnishing water for 25 years, the city to have the privilege of buying the plant at any time after ten years. The present supply is pumped from the Passaic River at Belleville and is notoriously impure. The new supply must be delivered by gravity at the present pumping station.

The perennial Cape Cod Canal is again before the Massachusetts legislature in the form of a petition for incorporation from citizens of Massachusetts.

Trolley boats are suggested for use on the Erie Canal and indorsed, among others, by Mr. T. H. Hanning, electrical engineer for the Field Electric Co., of Buffalo. The speed proposed is 12 miles per hour. The chief objection made to the system is the lateral motion of the boats in rounding curves; but engineers think they can overcome this difficulty.

The franchise is soon to be sold at public auction for about two miles of street railway in New York City, an extension of the Ninth Avenue line. The franchise provides that neither horse, steam locomotive power or any form of overhead electric transmission shall be used on the road, which practically leaves only the electric conduit and the cable systems to choose from.

Storage battery cars are to be tried on the Second Ave. line in New York City, in a few weeks. The Waddell-Entz system will be used.

Relaying track with trains passing at two-minute intervals is the close work done on the Manhattan Elevated Railway, in New York. Twenty men to a gang accomplish the work, unspiking and unbolting an old rail, and securing a new rail with fish-plates and four spikes in somewhat less than two minutes.

Competitive designs for a highway bridge at Lansing, Mich., were recently asked for, and about 18 designs were submitted. The design accepted was that of Mr. B. F. La Rue, of Jackson, Mich. The designs ranking next in order of merit were those of Mr. A. W. Buel, C. E., of Cleveland, the Cleveland & Canton Bridge Co., and Mr. C. E. Fowler, of Youngstown, O. The accepted design is for a three-span structure, 180 ft. in length. Each span consists of five lines of plate girders, 64½ ins. deep. The width of the bridge, out to out, is 79.86 ft. The roadway is of rectangular cedar blocks on 3-in. plank. The girders are designed for a live load of 100 lbs. per sq. ft., and the floor beams and stringers are designed for a load of 150 lbs. per sq. ft. The new bridge replaces a bowstring truss structure, erected in 1876, which has been condemned, and is too small for the present traffic.

The most serious railway accident of the week, and one of the worst that has occurred for some time, was a head collision Oct. 24, near West Falls, Pa., on the Philadelphia & Reading R. R. A southbound express train for Philadelphia, left Pottsville, Pa., at 7 a. m., and arrived at Phoenixville on time. There orders dated Reading were received to run on the northbound track from West Conshohocken to West Falls, a distance of only a few miles, regardless of all other trains. From West Conshohocken, in pursuance of these orders, the train took the northbound track. It was composed of a baggage car, a smoking car, two passenger cars, and a Pullman parlor car. The southbound track was blocked with freight cars. A train of empty coal cars started north from West Manayunk, on the northbound track, shortly before 9 o'clock. According to a published statement by Mr. Bonzano, General Superintendent, the coal train had orders to stop at Pencoyd to let the express pass, but the engineman and train crew state that they did not receive any such orders. The two trains came together on a curve. The engines were smashed, the front of the baggage car was crushed in, and the rear of the car and the forward end of the smoker telescoped. The greatest force of the collision was expended on the smoking car and the passenger car next to it, the smoker telescoping the day car half its length. The baggage car was smashed and thrown over on the southbound track in a heap with the engines. It caught fire, and was soon burned up. The next two cars kept the track. The second passenger car and the Pullman car were badly damaged, but not to such an extent as to prevent their being drawn away from the rest of the train directly after the accident. Except for scratches and bruises, the passengers in the last two cars escaped unhurt. There were 7 persons killed and 27 injured, some of them very seriously. One of the passenger was killed by being crushed under an overturned stove. On a road like the Philadelphia & Reading, with a very heavy freight and coal traffic, any delay in this traffic is liable to seriously interfere with the passenger traffic, and it is, therefore, not uncommon to allow a southbound passenger train to run on the northbound track to pass a block on its own track, a practice which is a very dangerous one.

Another railway accident was a derailment Oct. 23 at the crossing of the Chicago & West Indiana R. R. and Chicago & Grand Trunk Ry., at Forty-seventh St., Chicago. The accident occurred to a Chicago & Eastern Illinois R. R. outbound passenger train over the former road, consisting of an engine, baggage car, mail car, smoking car, day car, two sleeping cars, and two extra day cars in the rear. The day car in the middle of the train was derailed at the frog and overturned, and the two sleeping cars were derailed, but no one in them was injured. The day car was crowded, and of the people in it 1 was killed and 27 were injured.

The falsework of an uncompleted bridge over the Wenatchee River, Washington, on the line of the extension of the Great Northern Ry., gave way Oct. 25 under a construction train consisting of a tracklaying machine and cars of ties and rails. Track had been laid up to the bridge, and was to be proceeded with on the other side. The falsework of the second span gave way, throwing the cars and men into the water, 60 ft. below. There were 7 men killed and 11 injured, 5 fatally. The accident is said to have been due to the undermining of the falsework of the bridge by the water. That part of the road on which it occurred is still under the control of the contractors, and has not yet been accepted by the railway company.

An accident caused by the failure of a burned trestle, at Hayes, Miss., on the Louisville, New Orleans & Texas Ry., on Oct. 7, was noted in our issue of Oct. 13, and we are indebted for the following particulars to Mr. M. Gilleas, General Superintendent: The structure was a short trestle, 37½ ft. long, with three spans of 12 ft. 6 ins.; and the entire structure was destroyed. It was a standard wooden trestle with two bents, four piles in each. There were two stringers under each rail, and the floor was of 9-ft. ties, 6×8 ins., spaced 18 ins. c. to c. The trestle was thoroughly repaired in May last. There was no evidence of prior derailment. The bridge was either set on fire by persons unknown, or else caught fire from sparks from the engine. All weeds, grass, etc., under and around the bridge had been cleared away two days before the accident.

The "City of Paris," of the Inman line, has broken her own record in crossing the Atlantic westward. Her time from Queenstown to Sandy Hook was 5 days, 14 hours, 24 minutes on a course 2,782 knots long. The average speed was 20.76 knots per hour. For four consecutive days she averaged 511 knots, and one day made 530 knots. Her best previous record was 5 days, 15 hours, 58 minutes, made last July. Her daily run was as follows:

Friday, Oct. 14	448 knots.
Saturday, Oct. 15	508 "
Sunday, Oct. 16	503 "
Monday, Oct. 17	505 "
Tuesday, Oct. 18	530 "
To Sandy Hook Lightship	288 "
	2,782 knots.

The following table shows the reductions in time that have been made during the last two years by the transatlantic racers:

Vessel.	Time of Passage. D. H. M.	Average Hourly Speed.
City of Paris	5 19 18	20.01
Majestic	5 18 08	20.10
Teutonic	5 16 31	20.34
City of Paris	5 15 58	20.46
City of Paris	5 14 24	20.76

The Howden system of forced draught was used throughout the voyage. On a consumption of 310 tons of coal per day the triple-expansion engines gave an average number of 88 revolutions per minute.

The gross and net earnings of 129 railways for the month of August, according to the "Financial Chronicle," show a slight improvement over those of the previous month. The following are the figures for operations, compared with those of the corresponding month of 1891:

	1892.	1891.	P. C. Inc.
Gross earnings	$69,009,680	$65,224,341	5.8
Oper'g expenses	44,900,318	41,670,860	7.71
Net earnings	$24,109,362	$23,553,481	2.36

These show a very fair increase in gross earnings, but this is largely swallowed up by a heavy augmentation in operating expenses. Considering the different sections of the country, the detailed figures given by the "Chronicle" show a very large gain in net earnings, 20.62%, by the Southwestern roads. The next best results are shown by the Middle Western railways, an increase of 12.39%, and very favorable gains, 8.90% and 8.04%, respectively, are also exhibited by the trunk lines and the Northwestern lines. The smallest gain, only 0.39%, is shown by the Southern roads.

The Western Union Telegraph Company, its past officers and general progress was made the subject of his remarks by President Norvin Green, at the late meeting of the stockholders. In contrasting the condition of the company in 1867 and the present time, Dr. Green gave the following figures:

	1867.	1892.
Number of offices	2,505	20,700
Mileage of poles and cables	46,270	189,576
Average toll of messages	$1.04¼	31½ cts.

The gas companies of Chicago, according to the last annual message of Mayor Hempstead Washburne, paid to the city in 1891 the sum of $152,845. This payment was in accordance with an agreement designed to put an end to controversies between the city and the companies, made about a year ago, by which the companies contracted to pay the city 3½% on their gross receipts, and never less than $150,000 a year. In addition, the companies agreed to reduce the price of gas to private consumers by 5 cts. per 1,000 cu. ft. each year until the price reaches $1.00, and also made a reduction in the price of gas furnished to the city.

Vitrified brick paving was laid on 11 miles of streets in Philadelphia in 1891. Most of the brick was laid for light traffic. Lack of uniformity in hardness is the main trouble with the brick. The last report of Mr. Geo. A. Bullock, Chief of the Bureau of Highways, Philadelphia, states that brick pavement costs about 20% less than Belgian block or asphalt, and always presents a non-slipping surface. Portland cement has been substituted for pitch in filling joints, as the pitch always ran over the brick, making them slippery. Mr. W. H. Windrim is Director of Public Works.

Apyrite is a new Swedish powder of which the full composition is not obtainable. It is known, however, that nitro-cellulose enters largely into it. It is claimed that this powder burns without flame or smoke, is not effected by moisture or heat and can be handled and transported without danger. After 800 shots the gun was still clean. With the new Swedish magazine gun it is said that 3.5 grammes will give an initial velocity of 2,080 ft. with a pressure of 2,260 atmospheres.

A NEW STYLE OF IRON AND BALLAST BRIDGE FLOOR.

In our issue of March 23, 1889, we illustrated in detail the solid "buckle plate" or plate iron floor which is being used for all short span bridges on the New York Central & Hudson River R. R. This company was, we believe, the first in this country, to adopt as a standard a solid plate iron floor over which the ballast is carried uninterruptedly, thus doing away with the evils inseparable from open wood bridge floors however solidly constructed. Solid floors are standard in European practice. Recently, however, the New York, Providence & Boston R. R. has been putting in a considerable amount of iron and ballast bridge flooring on the same general principle, but of entirely different design. This floor, details of the construction of which are shown in the accompanying cuts, was designed by Mr. J. R. Worcester, Chief Engineer of the Boston Bridge Co., who has secured a patent for the design.

The bridge itself for which this particular floor was designed carries the single track of the New York, Providence & Boston R. R. into the station at Worcester, Mass., and consists of two plate girders 95 ft. 8½ ins. long each, placed 17 ft. 4 ins. apart c. to c. The bridge is located on a curve which necessitated the great width between the girders.

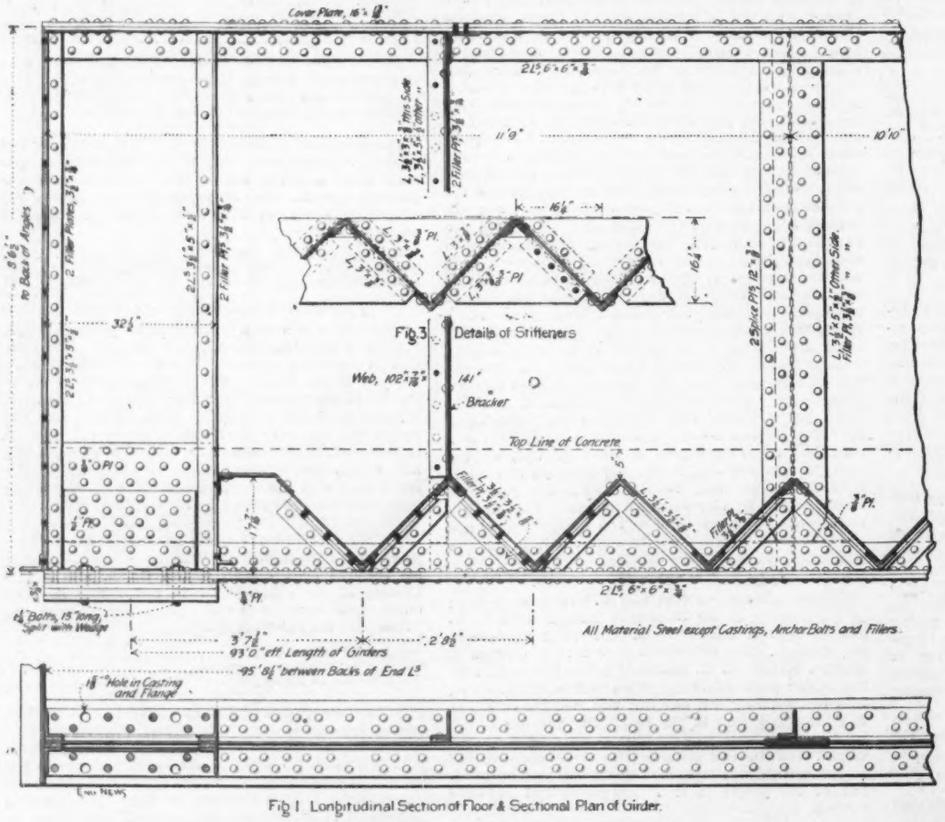
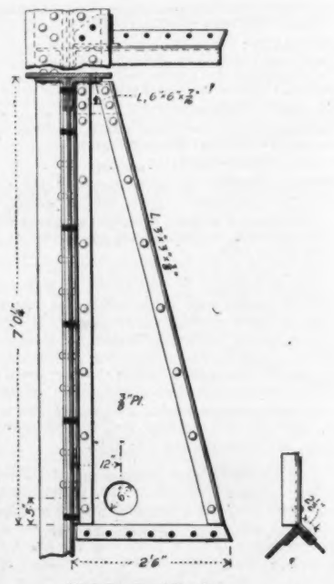

Cover Plate, 16"x ⅜"
Fig 3. Details of Stiffeners
Web, 102"x ⅞"
Bracket
Top Line of Concrete
All Material Steel except Castings, Anchor Bolts and Fillers.
93'0" eff. Length of Girders
95'8½" between Backs of End L's

Fig 1. Longitudinal Section of Floor & Sectional Plan of Girder.



IRON AND BALLAST BRIDGE FLOOR; NEW YORK, PROVIDENCE & BOSTON R. R. Designed by J. R. Worcester, Chief Engineer Boston Bridge Co.

As will be seen from Fig. 1, the floor consists of a series of parallel V-shaped troughs made up of angles and plates running transversely across the bridge and fastened to the girders by angles and brackets (Fig. 2). Along the center line of the bridge the floor is stiffened by vertical V-shaped plates fitting into these troughs and secured by angles. Details of the stiffeners are shown in Fig. 3. The troughs are filled with concrete to a height of 5 ins. above their tops upon which the ballast and the remainder of the track are laid in the usual manner.

The details and general construction of the floor are so clearly shown by the cuts as to need no further description. Unfortunately the company is unable to give us the weight and cost of this flooring compared with the ordinary types, but states that the simplicity of the shop work makes it very cheap. At any rate its economy is considered sufficient to make it worth while to have the system patented. We are indebted to the Boston Bridge Co. for the matter shown in the illustrations.

THE USE OF TRACTION ENGINES IN ENGLAND.

By Wm. Fletcher.

Five distinct types of traction engines are built in England at the present time, and may be classed as follows: 1, Agricultural locomotives for use on farms; 2, Road locomotives for heavy hauling purposes at slow speeds; 3, Road locomotives for carrying passengers, parcels, and light freight at quick speeds; 4, Self-propelling steam plowing engines; 5, Self-moving steam road rollers.

In addition to these standard types, there are a variety of road locomotives constructed for special purposes, some of which will be noticed later on, but the first two types of engines on the list will be mainly dealt with in this article.

The agricultural locomotive is suitably designed for driving threshing, dressing and straw elevating or chaff-cutting machinery, and for moving these machines from farm to farm. When the engine is not required for threshing, it is well adapted for working plowing machinery on the "round-about" system, and for hauling farm produce over the land, or along the highway at moderate speeds.

The second type of engine is more strongly built and is completely equipped for continuous hauling purposes on the road. The driving wheels are of large diameter, and the steel gearing and axles are of extra strength, in order to sustain the enormous wear and tear that these engines are subjected to. In external appearance and in constructive details these two types closely resemble each other, consequently most of the remarks in this article will apply to both series. As a matter of fact one or two makers have merged the two types of engine that may be used for agricultural purposes or for hauling work. If these general purpose engines are mounted on springs they will answer the requirements. During the last few years the number of traction engines employed in Great Britain and Ireland has increased at an amazing rate, in spite of the somewhat severe legal restrictions to which the owners of these engines are liable. Until quite recently three or four firms easily supplied the limited demand for self-moving engines; but as the trade gradually increased many other firms joined the ranks of traction engine builders, and at the present time there are no less than 30 firms in a position to turn out road locomotives. The unprecedented demand, however, shows no signs of abatement, the trade in this line being particularly brisk. The agricultural locomotive is rapidly supplanting the portable engine in every district in England. Not many years ago portable engines were used almost exclusively for driving threshing machines, but as soon as a traction engine makes its appearance in any threshing neighborhood, the portable engines from that moment are at a discount. The farmer prefers to hire the self-moving engine that hauls its threshing machinery to his farm, and starts work without any of his aid; for the portable engine and machine require the services of three of the farmer's men, and four or five of his horses, to remove them from some neighboring farm to his own yard. It is no wonder that the agriculturist will not trouble to fetch a portable engine, but gives his threshing orders to the person who owns a traction engine. It always appeared to be a mechanical absurdity for a portable engine to blow away the steam that might easily be utilized for propelling itself along the road, after the threshing was done. "About thirty years ago Messrs. Aveling & Porter, of Rochester, designed an arrangement for making these portable engines self-moving. They applied a pitch driving chain for transmitting the power from the crank shaft to the axle, and in other ways modified the construction of these strongly built engines, so that they would propel themselves along the highway, and draw a threshing machine behind."*

In some of these primitive self-moving engines, a horse was placed in the shafts for steering the

* "Steam Locomotion on Common Roads," by W. Fletcher. Published by E. & F. N. Spon, London and New York.

engine, and for the additional purpose of reconciling the horses met on the road by showing one of their own kind in front, as a pretense that the engine was being drawn along in an orthodox manner.

Among the 30 makers of traction engines there are several firms which can scarcely be recognized among the celebrated builders; they have drawings and patterns, it is true, and they do at remote intervals produce an indifferent engine that is noted for its strange appearance, and some of these engines are fearfully and wonderfully made. Some of the less known makers were once side by side with those who were the earliest in the field; they held their own for a time, but owing to some unfortunate circumstance they were unable to keep abreast of the times, and their antiquated productions make a poor show beside some of the modern specimens, but fortunately these old-fashioned engines are never seen outside a very limited area.

There are a few other firms among this number who build a fairly good engine, but they do not encourage the traction engine trade, because they possess other specialties that are said to be more remunerative.

After omitting the names of those who cannot be classed in the front rank, we are reduced to a dozen firms which build road locomotive engines which are substantial, trustworthy, and good as regards design and workmanship, and these firms naturally take the lead in this branch of business. The competition is so keen that the foremost makers are continually remodeling their designs, and improving the details of their engines to suit the varied requirements of their customers. The undermentioned firms are among the leading manufacturers, and their engines are universally good, yet each firm claims some advantageous feature not possessed by its contemporaries. The firms are as follows: Aveling & Porter, Rochester; Burrell & Sons, Thetford; Clayton & Shuttleworth, Lincoln; Foden & Co., Sandbach; John Fowler & Co., Leeds; Hornsby & Sons, Grantham; Marshall Sons & Co., Gainsborough; J. & A. McLaren, Leeds; Ransomes, Sims & Jefferies, Ipswich; Robey & Co., Lincoln; Ruston, Proctor & Co., Lincoln, and Wallis & Steevens, Basingstoke.

It is estimated that there are about 12,000 traction engines in use in Great Britain and Ireland. Messrs. Aveling & Porter alone, have made more than 4,000 self-moving engines, and a considerable number of these have been sent abroad. The foreign trade may be said to be in its infancy, yet several of the above firms are already doing a considerable European and colonial business. Judging by the immense number of portable engines shipped by English manufacturers to most parts of the globe,* there certainly appears to be a great future for the traction engine, for as surely as the self-moving engine has to a great extent superseded the portable engine for threshing in this country, so certainly will it (to a less extent) be used in foreign countries in preference to portable engines for this and similar purposes.

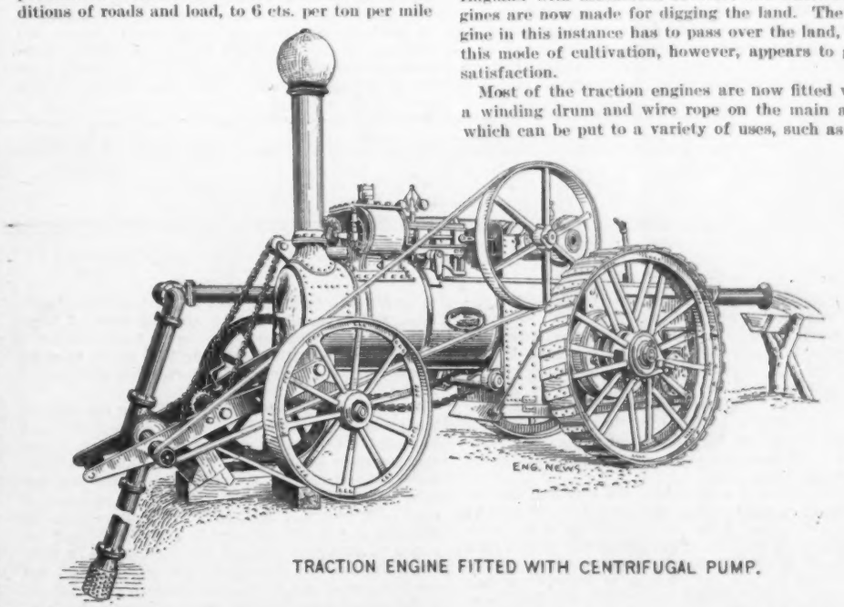
It is to be regretted that English agricultural engineers have not yet cast aside the meaningless term of nominal horse power. The absurdity of such an expression will be apparent when it is stated that a so-called 8 nominal HP. traction engine running at full speed, and working at the maximum boiler pressure, will develop 50 actual horse power on the brake. At one time the so-called 8 HP. traction engine having cylinders 9 ins. in diameter was most frequently used for threshing purposes, but since the working steam pressures have increased from 100 to 150 lbs. per sq. in., the tendency is to employ smaller and lighter engines which will do the same amount of work.

The compound system does not appear to be in very great demand, but it appears probable that it will eventually be adopted. Single cylinder engines are mostly preferred on account of their simplicity and their smaller first cost, and the reason for this is not far to seek. Most of the buyers of traction engines let them out on hire to farmers in their respective districts, and it must be borne in mind that any economy of coal or water gained by the use of a compound engine is reaped by the farmer who hires, and not by the owner, who will naturally prefer the simple engine, which suits his limited means better than the more costly compound engine. The three standard sizes of engines adopted for general purposes are as follows:

Cylinders, diam.....	8 ins.	8½ ins.	9 ins.
" stroke.....	10 "	12 "	12 "
Capacity of coal bunker.	448 lbs.	560 lbs.	616 lbs.
Capacity of tank, U. S. gallons...	138 gals.	150 gals.	168 gals.
Weight of engine empty.....	8 tons.	9 tons.	10 tons.
Weight of engine fully equipped..	9 tons.	10¼ tons.	11½ tons.

In regard to their hauling power this depends chiefly upon the state of the roads. On good hard roads a road locomotive with cylinder 9×12 ins. has drawn 40 tons up a grade of 1 in 15 (6.6%) in slow gear, exclusive of the weight of the engine, but inclusive of the weight of the trucks. A similar engine has easily drawn 20 tons up 1 in 10 (10%) in fast gear. But as bad country roads are not uncommon in England, it is safer to travel with lighter loads at quick speeds, reserving the slow gearing for extricating the engine out of difficulties, traversing bad pieces of road or climbing very steep grades, and in many parts of Great Britain there are grades of 10% to be encountered. The most economical load for good roads and moderate inclines is about twice the weight of the locomotive, but when the roads are level, this load may be much increased. The coal required by a road engine with cylinder 9×12 ins. when hauling say, 20 tons, is from 780 to 900 lbs. per day of 10 hours.

The working expenses, including wear and tear with interest on capital, vary from 2½ cts. per ton per mile for continuous work under favorable conditions of roads and load, to 6 cts. per ton per mile for short distances, with return journey unloaded.



TRACTION ENGINE FITTED WITH CENTRIFUGAL PUMP.

The cost of hauling by traction engines under favorable circumstances shows a saving of from 50 to 75% compared with the cost of doing the same work with horses. In one instance a heavy load was moved a considerable distance at a cost of $8.40 by means of a traction engide, while to have removed the same load with horses would have taken longer, and have cost about three times the amount.

One of Fowler's traction engines in two years has run 8,000 miles, taking 12 tons of coals each journey through the streets of Bradford, the steepest grade being 1 in 9 (11%) at a cost of half that of cartage by horses.

The traction engine with cylinder 8½×12 ins. is generally used for threshing, and when driving a 54-in. machine and straw elevator the consumption of coal is not more than 672 lbs. for 10 hours' work. An engine with cylinder 8×10 ins. has done 10 hours' threshing on 560 lbs. of coal.

At the latest trials carried out by the Royal Agricultural Society of England, a single cylinder traction engine built by Foden & Co. only consumed 2.56 lbs. of coal per brake horse power per hour, and the same firm's compound traction engine consumed 1.84 lbs. of coal per brake horse power per hour.

The following notes will give some idea of the multifarious purposes to which traction engines are now applied in England and foreign countries. They are employed for driving all kinds of machinery, for threshing wheat, barley, oats, peas, beans, rice and maize; for shelling clover; driving chaff cutters, straw elevators or stackers, and for grinding corn on the farm. One of their chief uses is hauling all kinds of loads on the highway, and sometimes over newly plowed fields. Many large corporations employ road locomotives for hauling their road metal from the dock or station as the case may be, and the same engine is used for working the stone breaker; moreover, some small town authorities can adapt the same engine for steam road rolling. Traction engines can be readily applied for plowing or cultivating land on the roundabout system, in which the windlass or hauling gear are usually placed in one corner of the field, the windlass being driven by pitch chain or by belt from the engine. In some instances drums have been mounted upon the engine and driven direct by spur gearing. These engines are quite distinct from the plowing engines under the fourth head, which are for plowing on the double engine system. In Italy and some parts of France large numbers of traction engines are used very successfully for plowing the land by direct traction, the engine traversing the hard soil and drawing a three-furrow plow after it. The engines are generally built specially for this purpose. This method of plowing has many times been tried in England with indifferent success; but traction engines are now made for digging the land. The engine in this instance has to pass over the land, but this mode of cultivation, however, appears to give satisfaction.

Most of the traction engines are now fitted with a winding drum and wire rope on the main axle, which can be put to a variety of uses, such as the pulling down of trees that have been partly sawn through, and the extricating of the tree stump; on the front of the engine, intended for work of this kind, a steam cross-cut saw is fitted (steam for working the same is supplied by the engine). The saw cuts the trees into convenient lengths and by means of the winding drum, the logs are drawn up an incline onto a timber carriage, and hauled to their destination by the same traction engine.

Colonial timber merchants are using road locomotives for loading and carting timber, and some of these engines have a crane attached to the smokebox end. These crane engines are also used for military purposes, on engineering works, and in many other situations where heavy weights have to be lifted and conveyed to a distance. Another use is found for traction engines in districts where the irrigation of the land is necessary. A swiveling centrifugal pump fixed to a light plate iron frame hung on the engine's front axle is readily lowered near the surface of the water, and a belt drives the pump from the engine fly wheel. When it is necessary to move the engine the pump is quickly hoisted up and the engine is at once ready to transport the apparatus to another spot. An engine

*Messrs. Clayton & Shuttleworth have made 27,000 agricultural engines, mostly of the portable type, during the last 45 years. Messrs. Marshall, Sons & Co. have manufactured in 30 years upward of 20,000 engines of more varied types.

fitted with this arrangement is shown in the accompanying cut.

Traction engines are frequently employed for electric lighting purposes. The dynamo is occasionally placed on a platform fixed in front of the smokestack, and can readily be driven by a belt from the fly wheel. Some engines sent a few years ago to Suakim, Egypt, for search light purposes, had the dynamos placed over the crankshafts on the top of the box brackets and driven by spur mortise gearing. The showman finds it to his advantage to adopt the useful traction engine for working his steam circus, and lighting up the show by electricity, and also as a means of drawing the entire paraphernalia from town to town, the same engine performing the three duties. Several traction engines are used for drawing cages of wild animals along the roads by day, and at night employed for lighting up the exhibition under canvas. The author recently saw two traction engines engaged in hauling up parts of the machinery of a wrecked steamer on the Norfolk coast. The engines were placed on the cliff, and at low water the steel wire ropes from the winding drums were attached to heavy portions of the engines, and quickly drawn on to the beach.

In the next article will be given some practical notes on the design and construction of English traction engines.

EXPERIMENTS ON THE EXPANSION OF CONTINUOUS RAILS.*

In street railway track construction to-day, the question of paramount importance is that of the joint. It is not, perhaps, generally known, but it is nevertheless a fact, that the joint of the formerly despised street railway has already distanced in perfection its former leader, the steam railroad.

The joint of the steam road is exposed, and, therefore, accessible. That of the street road is not; it is practically inaccessible. It has been proposed to overcome this by making it accessible by means of boxes with removable covers. Apart from the objection that this adds to the amount of street taken up by the track, the cost, if properly done, is almost prohibitory. I have been informed by the manager of one of our largest and most progressive street railway systems that, after a careful trial, it was found to be cheaper to take up the paving and tighten the joints once every few months than to pay the interest on the investment in the boxes.

The essentials of a good joint are embodied in very few words, to wit: "absence of motion;" and it must be absence of motion of the cars as well as of the rails, particularly in the case of electric roads. If two rails be placed in perfect surface alinement and closely butted, and so held, the problem is solved. Not only must they be true to surface and line, but they must be abutted. It will not do to leave the usual expansion space. This can be quickly demonstrated by cutting a groove ¼ in. wide in the head of the middle portion of a rail. The surface and alinement are here true, but the ends are not abutted. A slight jar can be felt from the first; in a short time it becomes worse, and after continued use, bad and rapid wear, accompanied by a low spot, results. In this case there is no motion of the rails; the evil results from the motion of the cars. This, however, goes without saying, as, of course, the cars are the destructive agency; and it is only emphasized because it is a very prevalent opinion that if the rails as laid to-day could only be held rigidly level, the problem would be solved.

A few words as to the evolution of the joint: Ignoring the old stringer construction, the first step toward improvement was taking a leaf from the steam road, which was at that time far in advance of the street railway, at least in this country. The girder rail of to-day was in general use abroad some time before it was adopted here; but when adopted here, its advent at once permitted the use of the ordinary splice bars, in which the bevel of the plates fitting between similarly beveled portions of the rail, and drawn into place by bolts, tightened the joint. So amply strong was this joint considered, that at first it was deemed possible to economize in material, the bars and bolts were made light, and the bearing surface small. With the horse car it appeared satisfactory. The development of cable roads, however, at once indicated the weakness of the early practice, and the size of the bars and bolts was increased, and much larger bearing surfaces were provided, in the shape of channel splice bars. The appearance of electric cars showed even this improvement to be inadequate. It was found that the wear was concentrated at the rail ends, and a splice bar which had become useless because of actual wear at this point, showed no wear at the extreme ends.

The problem was then attacked with the idea of stopping all motion. To do this, two points were essential: (1), To hold the rail against motion by means of the fastening bars; for which it was necessary to, (2), hold the fastening bars against motion by means of bolts.

As to the first: Not only were the bars made of great rigidity both vertically and laterally (for both are essential), but they were made to fit the rail. If anyone will carefully examine an ordinary splice bar after it is tightened, he will be somewhat surprised at the result. If he takes a thin piece of paper and tries to work it into the fit, he will probably come to the conclusion that he has not more than 50% of real bearing or fit, as compared with the apparent bearing. No matter whether the track comes from a careful or careless manufacturer, nor how rigid the inspection, the evil will be found; it is only a question of more or less. It is due to the absolute impossibility of making a fit between rolled surfaces when the structure is rigid. A good machinist will tell you that even with the lathe or planer this is a difficult achievement, let alone without. To avoid this a spring or yield was introduced, and this under conditions demanding rigidity as a sequence. In other words, the springing or yielding portion was in itself of great rigidity, and only made to yield by excessive tightening power. Hence, the bearings, while strong and rigid in themselves, were made to spring or yield to a fit when tightened home by bolts large in diameter and many in number; and to secure this, very deep bars of great structural stiffness, which permits of two rows of bolts of large diameter, were developed. It must be remembered that this must all be embodied in the joint itself; to make a poor joint and then merely support it, has been proved a total failure.

As to the second point, properly holding the bars: A large number of bolts was the first development, and increased size or diameter followed. A nut lock to prevent slackness has been experimented with. If without spring to take up, not only the slack of the nut, but also the stretch of the bolt, it is useless, and few, if any, exist with this desideratum. A bolt so large in diameter that it will not stretch, and threads well cut and tight fitting, so that the nut is not liable to turn, are to-day the best safeguards. Not only the size, but the location of the bolts, is an important factor. It is the jolt or impact of the car that loosens the nuts. The vibration passes along well-defined lines. If the bolts are located in the line of greatest vibration, the nuts will tend to turn more quickly than if located elsewhere. A double row of bolts with the lower row staggered, gives excellent results. A single row does not suffice.

Such is the joint of to-day, structurally stiff, heavy enough to take up the jar of the blow without transmitting it all to the nuts, a yielding fit that tends to counteract all motion, and large bolts, carefully located with a view to absorb vibration. In itself good, and as it now stands, to a certain extent, capable of economical use, and far ahead of its brother on the steam road, even of the heaviest construction.

But even this construction will not do, and the query is, "What, then, will do?" There is but one answer. No joint at all. While apparently a bold suggestion, it is, at least, worthy of thought and discussion. That the rail can be made continuous by mechanical means, we know; but what of expansion and contraction? We will do without it; and that we can do so, the sequel, I think, will show.

To the credit of Mr. Philip Noonan, I think, should be placed the first practical idea of a continuous rail. His plan, in a nutshell, may be described as gripping the rail at one end, and permitting the wave motion or flow induced by passing trains to be, so to speak, rolled out before the train wheels, into a tension device that within certain limits holds what it gets. He provides against danger of rupture by a spring device which limits the strain. He put his ideas to a test, built a considerable stretch of track (some three miles) on the Lynchburg & Durham R. R., at or near Gladys Station, Va., and it is to-day in successful use. Expert investigation and report indorses it in all essential particulars, though it is, perhaps, questionable whether the fastenings he used to make his rail continuous are strong and rigid enough to prevent all yield. For details, those who care to investigate may be referred to a pamphlet on the subject, that can be obtained by addressing the inventor at the above named place.

At a glance, the problem of a street railway differs from the steam road in that the former is surrounded by the roadbed, while the latter is, at least to a great extent, exposed. The effect of the surrounding roadbed is twofold: (1), By its great surface friction it tends to hold the rail against change, stops all wave motion, and, (2), It to some extent modifies the temperature.

The problem was to find a measure of value for both. To solve it the following experiment was made:

One rail in a section of track was so connected as to form in reality a continuous rail. One rail of the track was taken instead of both, because it was thought the adjacent parallel rail would at once indicate changes which were expected to occur, that other measurements might perhaps fail to disclose. The length was 1,100 ft., and the profile one that embodied level track, up grade and down grade. As the track was laid and in use, it was determined that it was best to make the rail continuous by a rigid joint stronger than the rail, so as not to have to remove the whole roadbed. The roadbed, which was of macadam, had become solidly packed, and represented normal conditions hard to obtain if once disturbed. Remember that when the experiment was made it was thought questionable whether the rail, when prevented from expansion and contraction, could be at all restrained by the roadbed; hence all the restraining power offered was to be retained. At the end of each separate rail the usual ¼ in. had been left for expansion. This was filled by a carefully measured dog, which was made of the same section as the rail, was cut to fill the space tightly, and was then driven into place.

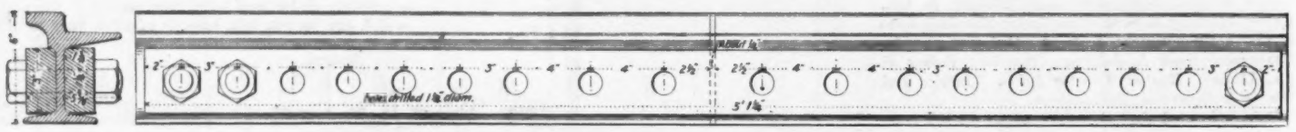


FIG. 1. RAIL JOINT USED IN EXPERIMENTING ON THE EXPANSION OF A CONTINUOUS RAIL.

For the joints, body-bound, machine-turned bolts were decided upon, with two side bars of steel, 4 × 1¾ ins. × 5 ft. 4¼ ins. The body-bound bolts were 18 in number, and 1¼ ins. in diameter. (See Fig. 1.)

As is well known, one of the most difficult things in metal working is to secure a real fit between two surfaces. The usual work of a machine tool—be it lathe, planer or what not—is very far from accurate, as the introduction of template work into a shop soon shows. Among average machinists, it is rare to find one in ten capable of making a real fit. To insure an absolute fit was deemed a necessity. It was done as follows: A number of jigs were made having a hardened steel guide for the drill. With this the bars were drilled in pairs, and as drilled, each bar was carefully tested by the standard. The holes were drilled 1-32 in. smaller in diameter than ultimately needed. The roadbed surrounding a joint being removed, one bar was clamped to the rail, and the holes (also 1-32 in. small) were drilled through the web, using the bar as a guide. After the temperature of the parts was equalized, the adjoining bar was then adjusted and a rose-bit reamer was carefully worked through the three holes. As quickly as one hole was completed its diameter was gaged, and a machine bolt (previously turned to a standard slightly large) was turned for this special hole. The accuracy of the work may be shown by the fact that after reaming, if anything interfered with the equalized temperature (as for instance one bar being removed and laid in the shade during the work), the bolts could not be put home. Each bolt was a driving fit. It took 24 hours to properly adjust each joint; but when done the track was made continuous.

At five points along the line heavy stakes were firmly fixed in the ground, one on each side of the road, in the top of which were set small wire nails. A thin but strong cord was tightly stretched from stake to stake, the tops of which were several inches above the top of the rail. Directly underneath this line a mark was made on the head of the rail with a cold chisel. Measurements were taken from the stake to the chisel mark, and from the top of the rail to the tightly stretched cord. Observations were taken at these five

* Slightly condensed from a paper by A. J. Moxham, Johnstown, Pa., read at the Cleveland convention of the American Street Railway Association.

points, in the manner indicated, throughout the whole summer.

The work was started on March 19, and finished on April 25, 1892. The average temperature during the work was 43.04°, the maximum 81° and the minimum 10°.

The section of rail used in the track is of the girder type, 6 ins. deep, weighing 78 lbs. per sq. yd., and shown at A, Fig. 2. The rail is fastened to the ties by means of tie-plates, and the gage is preserved by tie-rods spaced 10 ft. apart. The ties are spaced 11 to 30 ins. apart, and the roadway is excellent macadam.

Anticipating the unknown, provision was made for a possible sudden stoppage of the line, by means of portable connecting tracks kept in readiness. Careful preparations were made to read the temperature of the rail at different parts above and below ground, during the experiment. As the rail was in use, this was done by a special rail in the adjoining roadbed, and in order that the investigation should be complete, the temperature was continuously taken at the head of the rail and at the lower flanges, of a 6-in. rail, of a 7-in. rail, and of a 10-in. rail, or its practical equivalent, a 10-in. I-beam. Simultaneous readings of temperature were taken of the air in the shade, air is the sun, and of the roadbed at depth of 7 ins. and 10 ins.

The thermometers were carefully tested for accuracy at all temperatures, from freezing to their highest reading. They were graduated to quarter degrees.

The rails were imbedded in macadam, and in such a manner as to most closely resemble the conditions found in an actual roadbed. The thermometers were inclosed by a box with sides of wire netting admitting the air freely, and intended only to protect the thermometers from accidental breakage.

Many thousand readings were taken during the experiment, which was continued from April to September. The general average of all the day readings showed a temperature of the head of the rail 1.70° less than air in the shade, and of the flange of the rail

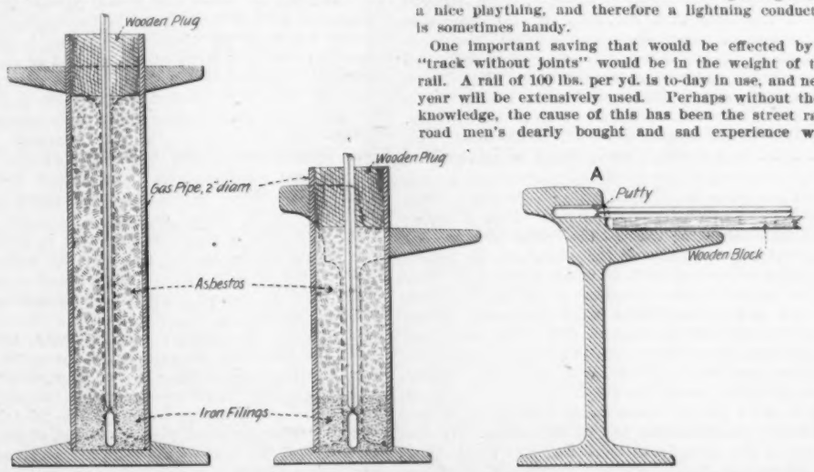


FIG. 2. SECTION OF RAIL USED IN TEMPERATURE TESTS, SHOWING POSITION OF THERMOMETERS.

(Section of Rail Used in Experimental Track is Shown at A)

2.66° less. The average of all the night readings showed the head of the rail to be 3.36° warmer than the air and the flange of the rail to be 5.14° warmer.

This proves that for all ordinary purposes, the rail may be assumed to be subject to nearly full air temperature, and that the roadbed will not suffice, as has been believed, to keep the rail temperature virtually regular. Steel is a far better heat conductor than earth, and, as the tables show, the whole rail (flange as well as head) closely follows the air temperatures.

Now for the effects of this heating and cooling of the rail. The experiment has proved absolutely and beyond cavil, that expansion and contraction is restrained and held by the surface friction of the surrounding roadbed. From first to last, from a temperature of 22° below the freezing point (or 10°), to a temperature of 89° above freezing point (or 121°), extending from March to August, there was absolutely no movement of the track out of place. Even at the ends was this true; proving that not only will the roadbed hold the track as a complete structure, but that it will do it consecutively. Once bedded, it will hold a rail 10 ft. or 30 ft. long as well as one 1,100 ft. long.* On this point there is no room for error. The expansion in 1,100 ft., if not neutralized, would equal 5¼ ins., under the change of temperature stated, and 5¼ ins. would throw the rail out of line 14 ft., if it were held at the ends and permitted to bow in the center. The expansion of a single rail would mean about 6 ins. in 30 ft. out of line.

* (Mr. Moxham seems to be in error here, as we have explained in our editorial columns.—Ed.)

The query arises, "What has become of it?" It is existent, and, like all force, it would flow to the point of least resistance. In the case of a street rail, buried in the roadbed, it is reasonable to believe that the effect of the tendency to expand and contract is a minute enlargement and reduction of the sectional area of the rail.

As to its effect upon the steel: Experts teach us that a variation of 7° in temperature, if held, would subject the rail to a stress of 1,000 lbs. per sq. in. Taking a track laid at the low temperature of 40° and subject to a maximum of 120°, or a variation of 80°, the stress is equal to less than 12,000 lbs. per sq. in. This is much less than the elastic limit, and less than the strain put upon an ordinary bridge, or similar structure. It would therefore appear that the effect on the steel would be harmless.

On the face of it, therefore, there is nothing to prevent us abutting our rails, and this is but the prelude to an absolutely continuous track—one without joints—the rails welded by electricity, or otherwise connected one to the other, up to such lengths as may be deemed best.

As to its practical application, many precautions suggest themselves. It must be remembered that a track so laid will be like a huge spring under compression, absolutely safe and harmless when restrained by the roadbed, but ready to spring like a shot from a cannon if, while in this condition, the roadbed be removed. The part of common sense would appear to be to limit the length of a continuous rail to, say, 500 to 1,000 ft., with specially devised expansion joints at these intervals; or if desirable to take up the paving for repairs on a very short piece, the following would be effective: First, remove only a foot of paving, then with a hack saw cut out, say, 6 ins. of rail, thus removing the tension or compression, as may be. This done, the rest of the roadbed could be removed, starting from the cut part of the track, without danger. Be this as it may, it should be borne in mind that chained lightning is not a nice plaything, and therefore a lightning conductor is sometimes handy.

One important saving that would be effected by a "track without joints" would be in the weight of the rail. A rail of 100 lbs. per yd. is to-day in use, and next year will be extensively used. Perhaps without their knowledge, the cause of this has been the street railroad men's dearly bought and sad experience with joints. The joint being defective, the effort has been made to secure such stability of track as to relieve the joints by means of a heavy rail. In a 100-lb. rail there are but 30 lbs. of wearing surface, of which not more than 18 lbs. can be used before the rail will have to be thrown out; therefore there will be 82 lbs. unused. For mere stiffness and rigidity, a 66-lb. rail, if supported by the proper number of cross-ties, will answer every engineering demand, even of electric cars at high speed. Anything over this goes to the debit of "bad joints."

OBSERVATIONS ON CONSUMPTION OF WATER AT PHILADELPHIA IN 1891.

The per capita consumption of water at Philadelphia, as in nearly all American cities, great and small, has been steadily increasing for several years. A part of this increase is due to the fact that the proportion of the population using water from the public works is increasing in most cities, for it must be borne in mind that figures of consumption are generally averages per head of population and not of actual consumers. In addition the use of water for the motive power of elevators and light machinery and in manufacturing generally is increasing more rapidly than the population.

The following interesting observations on the consumption of water in three small districts of Philadelphia were made in 1891 and are taken from the last annual report of the Department of Public Works, Mr. John L. Ogden being Chief of the Bureau of Water:

The total number of gallons consumed was 54,078,916,408, a daily average of 149,805,250, which is a per capita consumption of 140 gallons on an estimated population of 1,071,672. This is an increase of nine gallons over the year, and 40 gallons since 1888.

Some experiments have been made for the purpose of accounting for this increase, one in the center of the city and two in manufacturing districts.

The first selected was the square between Broad and Thirteenth and Walnut and Spruce Sts., which was isolated by closing the necessary stops at Juniper and Walnut Sts., where the water passed through a 6-in. meter.

A house to house inspection was first made for leaks. Three spigots were found wasting some water, and they were repaired. No other leaks could be detected. All of the houses were supplied with curb stops to shut off the water.

This district contained 131 buildings, as follows:

Dwellings	104	Library	1
Dwellings and stores	3	College	1
Dwellings and stables	2	Theaters	2
Stables	12	School	1
Stores	3	Club house	1
Historical society	1	Total	131
Population			704

There were no manufacturing establishments, and the appliances for the use of water were as follows:

Hydrants	96	Water closets, in yard	16
Wash paves	71		
Spigots, kitchen	384	Water closets, flush tank	134
Spigots, bath tubs	244		
Spigots, wash tubs	12	Urinals	13
Spigots, wash stands	255	Urinals, stalls	5
Spigots, in cellars	38	Motor	1
Spigots, in bar room	3	Beer pump	1
Spigots, fire hose	19	Ice cooler	1
Spigots, pantry	74	Steam boilers	2
Water closets, with handle	41		

The water rents amount to $2,335.55.

Readings of the meter made every hour from Nov. 4 to 18, inclusive, showed an average daily consumption of 89,760 gallons, equal to 113 per capita.

Forty-one and four-tenths per cent were used between 6 p. m. and 6 a. m., and 48.6 per cent. between 6 a. m. and 6 p. m, or

Between 6 p. m. and 12 p. m.	28.1	gallons per capita.
Between 12 p. m. and 6 a. m.	18.7	" " "
Between 6 a. m. and 12 m.	33.	" " "
Between 12 m. and 6 p. m.	33.2	" " "
Total	113.	" " "

It was at first supposed that on account of the large amount of water passing through the meter between 12 p. m. and 6 a. m. there were some leaky pipes, but none could be discovered.

Three urinals and five urinal stalls were found to be constantly running. It was not practicable to measure the water used by them, but by metering similar appliances, under similar conditions, an approximation was made. It is certain that they use not less than 43,450 gallons daily, one-fourth of which is within 3,928 gallons of the total used between 12 p. m. and 6 a. m.

In addition to the above there were eight siphon urinals running constantly, but the amount of water they use has not yet been ascertained.

	Gallons.
Average consumption, 704 people, 24 hours	89,760
Three urinals	3,450 gallons.
Five stalls	40,000 gallons. 43,450
	46,310

This amount represents a consumption per capita of 58 gallons, exclusive of the water used by the urinals. By the constant running of these appliances nearly 50% of the water used passes through them.

By experiment it was found that the least amount of water that can be used to effectually wash urinals with the water running constantly, is 1,150 gallons daily, or 419,750 gallons yearly, which at meter rates amounts to $33.58. The rent now charged is $2..

Running at full capacity, as some do, they would each use annually about $179.85 worth of water at meter rates.

The examination of this locality will be continued with the assistance of a Deacon waste water meter.

Similar examinations should be made over the entire city. Much waste could be prevented, but this experiment shows that the largest proportion of the waste is legalized through appliances that of necessity use a large amount of water. The only check that can be put upon them is a meter, which will either make payment for the water used, or compel the shutting off of the water when the use of the appliance is not required.

The second experiment was made by placing meters on the mains supplying a large manufacturing establishment in the Twenty-eighth Ward. During the first eight days the water passed through the meters at the rate of 600,000 gallons per day, or 219,000,000 per annum. The water was delivered under 140 lbs. pressure from the Roxborough reservoir.

The water pumped at Roxborough supplies Manayunk,

Falls Village, Chestnut Hill, Germantown and Tioga, the total for the entire year being 3,745,192,134 gallons.

It will thus be seen that one-seventeenth of all of the water pumped at this station was used by this one establishment, which should pay by meter rate the sum of $17,520 annually. The amount charged by assessment is but $1,792.

The third experiment was made in a manufacturing district in the Thirty-first Ward, which contained:

200 dwelling houses.	2 stores.
13 manufacturing establishments.	1 church.
	1 slaughter house.
7 dye houses.	2 offices.
5 stables.	1 saloon.

The resident population was 849, and the transient population employed in the mills and dye houses numbered 1,733.

The water consumed amounted to 1,292,544 gallons daily, or 1,522 gallons per capita of resident population. These investigations were only preliminary, and to obtain experimentally some idea of the best manner of conducting further examinations throughout the entire city for the purpose of stopping waste and reducing the per capita consumption, and for increasing the revenue of the city from water rents.

COMPETITIVE DESIGNS FOR A DRAW-BRIDGE OVER THE DULUTH SHIP CANAL, DULUTH, MINN.

(With insct.)

We show on our inset sheet this week the general plans of twelve of the twenty competitive designs submitted to the Board of Public Works of the city of Duluth, Minn., for a drawbridge over the ship canal on Lake Ave. in that city. Full details of the conditions for this competition were given in our issue of Feb. 20, 1892, together with a synopsis of the various designs presented. A brief review of the principal facts, however, will be of interest, and will aid in the study of the comparative merits of the several designs illustrated.

As will be seen upon examination of a map of the western end of Lake Superior the harbor of Duluth is separated from the lake by a narrow peninsula, known as Minnesota Point, which runs nearly parallel to the adjacent shore for a distance of about seven miles, and at its extremity meets a similar peninsula known as Wisconsin Point. A few years ago a canal 250 ft. wide was constructed across this point near the Duluth shore in order to obviate the necessity of a long detour by ships entering the harbor. With the growth of the city the value of Minnesota Point for business and railway terminal purposes largely increased and canal became a serious hinderance to its utility, severed as it was from the main business section of the city. Consequently in November, 1891, the Common Council authorized the Board of Public Works to advertise for competitive plans for a bridge across the canal and to offer a prize of $1,000 for the best design submitted. The conditions of the competition required a draw bridge which would leave the entire width of the canal free to passing vessels, and which would provide for a single railway track, two electric railway tracks, two highways and two sidewalks. As before stated, designs were submitted by twenty different competitors.

After careful consideration the board decided to award the prize to Arentz & Sangdahl, of Milwaukee, Wis., as having submitted the best and most carefully studied design for the drawbridge proper. At the same time it considered that a bridge which would accommodate the traffic for some years, or until such a time as the city felt it was able to tunnel the canal, could be built for much less money than it would cost to built the Arentz & Sangdahl bridge. It accordingly recommended the Common Council to adopt the design presented by J. A. L. Waddell for a lift bridge, which was done. Meanwhile a protest had been filed at the War Department at Washington against the construction of the proposed bridge. Accordingly a committee of Government engineers was appointed to hear testimony for and against the construction of the bridge and to present a report to the War Department. The result of this report was that the department expressed itself adverse to the construction of any bridge at all. This is at present the status of affairs, and the Board of Public Works now recommends a tunnel as being less troublesome to operate, though more costly than a bridge to construct.

The illustrations of the several designs shown on the inset sheet are necessarily limited to the general features of construction and operation. They are intended merely to afford a means for a comparative study of the different plans. In making this study it is necessary to keep in mind the conditions to which the structure must conform in its construction and operation. The traffic on the canal is very heavy during the busy season, as many as 35 vessels per day entering the harbor by means of it. The bridge must afford as little hindrance as possible to these vessels and yet provide for a very heavy street and railway traffic. This necessitated rapidity and certainty in its operation. The conditions of the competition required the full width of the canal to be left free, and prevented the use of a swing bridge with a center pier. In addition the great cost of land on the canal banks necessitated the use of as little space as possible in the operation of the bridge. The methods by which the several designers aimed to overcome these conditions is shown by the illustrations and the following brief descriptions of the various designs:

F. C. H. Arentz and L. E. Sangdahl.—As stated before the design of Messrs. Arentz & Sangdahl, of Milwaukee, Wis., was awarded the $1,000 prize by the Board of Public Works. It provides for a single sliding draw carrying the railway and street traffic on different levels. To open and close the draw the bridge is rolled forward and backward on a track. The weight of the structure is carried by the central tower, which is so constructed that it affords a high degree of stability, being battered and well braced on all sides. It also distributes the weight, amounting to some 1,200 tons, on a large area, each of its twelve legs being supported by a truck, under which are six double wheels, each running on two 70-lb. steel rails resting on a heavy wrought iron plate anchored to the masonry. These double wheels are 3 ft. in diameter, with a 10-in. face, having a heavy flange in the center.

In order to utilize the heavy foundations needed for the tower to roll back on, extending to a point 316 ft. from the canal, and thus effect a saving of material in the trusses, the bridge is supported at every panel point of the shore arm by beams resting on trucks, each of which is provided with four single wheels occupying a part of the same track as the main trucks under the tower. These wheels are 2 ft. in diameter, with a 5-in. face, and with a flange on the inside. The trucks under the shore arm, when the bridge is in motion, simply act as guides, excepting the trucks under the three last panel points, which carry the excess of the 200-ton counterweight put in for safety. At the end of the canal arm there are two toggle-joint lifts serving to raise the end sufficiently to relieve the tension in the two top chord panels next to the tower. These lifts are operated by an electric motor. From the illustrations it will be seen that all trucks turn out from the bridge before reaching the track-pit, which in this way is left unobstructed. The railway track on the bridge is reached by trestle approaches joining to it both at the channel end and on one or both sides of the shore arm. The bridge is moved by six 1½-in. steel ropes, arranged in pairs, running over equalizing sheaves 5 ft. in diameter, and wound on grooved drums, 10 ft. in diameter and 30½-ins. face, attached to the main shaft coming from the power house located at one side of the bridge, near its end. The engine is a 116-HP. reversible twin engine, provided with powerful brakes so constructed that they are always on, unless relieved by the engineer. There is a separate regulating and reversing engine, which gives an accelerated motion at the beginning of the run and a retarding one toward the end. This engine will also by itself prevent the bridge from running beyond its extremities. The main engines have 28-in. cylinders and 48-in. stroke. In the engine room there is also an electric light and power engine, 10-in. cylinders and 24-in. stroke, operating a dynamo, which supplies electricity for illumination of the bridge and for signals, and also for the end lifts previously mentioned. The time consumed in opening or closing the draw is one minute. The total estimated cost of the bridge is $236,000.

Onward Bates and James N. Warrington.—This design was submitted by Messrs. Bates and Warrington, of Chicago, Ill., on its general features with the understanding that it was not eligible for the prize, as it did not conform to the requirements of the competition. It is for a swing bridge supported at one end upon a rim bearing turntable and at the other by a pontoon. To open the bridge the free end is lifted from its bearing on the abutment by pumping water from the pontoon and is then swung to one side or the other by the propelling power of a screw working in a tunnel, or hollow shaft, in the pontoon. In order to secure a clear channel slips are provided for the pontoons when the bridge is open. At the fixed end the span is hinged over the center of the turntable to permit of the vertical motion. A screw and engines of a capacity of those of a large steam tug are considered sufficient to operate the bridge. The time of opening is estimated at 1½ minutes under ordinary conditions and 3 minutes against a 5-mile current. The estimated cost of the bridge is $80,000.

A. S. Cooper.—The single design submitted by Mr. A. S. Cooper, of West Superior, Wis., was for a single sliding draw consisting of a channel arm of 260 ft. span and a counterbalanced shore arm carrying the machinery. The draw is designed to slide back inshore on friction rollers hinged together in a flexible band so that they may be carried around a curved track from the bottom side to the top side of the bottom chord and stored, when not in use, as shown in the illustration. These rollers are made to follow this course by means of a small wire cable attached to the end of the band of rollers, and thence passing around a sheave to a friction drum in the engine room which takes up the slack. The bridge is moved by means of three large cables, one end of each of which is fastened to the face of the south pier and the other to an anchorage about 400 ft. south of this pier. These cables lie in slots along the bridge track, and at the first vertical post pass around sheaves and thence once around each of the two winding drums and thence descend again to the tracks, passing around sheaves to the fastenings at the face of the pier.

At this point a screw arrangement is provided for taking up the slack. To move the bridge in either direction only involves going ahead or backward with the engine, which is an ordinary 8-HP. hoisting engine, fitted with special gear wheels and drums. To overcome the difficulty arising from the fact that the railway at the north end of the bridge is some three feet or more above the tracks that the bridge itself runs on, the railway tracks are arranged for a down grade of a little over 2% from the south pier to the end of the approach, and the ends of the rails are so arranged that this approach can be lifted about one foot, by means of secondary cables and drums, thereby allowing the tracks on the approach to pass above the tracks on the street. This arrangement also serves as a lock when the bridge is closed. At the north end of the bridge the rollers are so arranged that when the bridge begins to roll back the load will be taken off them by means of a heavy counterweight of ballast stored between the track stringers and floor beams at the other end of the bridge. The estimated cost of the bridge is $81,130.

E. B. Jennings.—A design for a double swing bridge was submitted by Mr. E. B. Jennings, Engineer of the R. F. Hawkins Iron Works, of Springfield, Mass. Each half of the bridge consists of a channel arm and a shore arm supported on a rim bearing the turntable. To open the draw the two halves of the bridge are swung around by the usual lifting and turning machinery, leaving the channel clear. The estimated cost of the bridge is $170,000.

Benjamin F. La Rue and L. D. Grosvenor.—The general features of the design presented by Mr. Benj. F. La Rue, of Jackson, Mich., are very simple. They are an ordinary truss bridge surported as one end upon a turntable and at the other by the abutment when at rest, and a small propeller, which supports the free end of the bridge when moving and also supplies the motive power for its operation. Owing to a draftsman's mistake in the plans from which our illustration is made

the lateral sway bracing is incorrectly shown. The mistake was discovered too late for rectification. The draw when open leaves the channel entirely clear, a slip being provided for the propeller so as to allow the structure to swing over the bank of the canal. The point of interest in this design is the construction and operation of the propeller. This is of steel, 70 ft. long, with a width of beam of 20 ft. and a draft of 15 ft. It has a propeller at each end on a single shaft operated by high pressure engines. Besides the propelling machinery it is provided with quick service pumps and compartments for water ballast for raising and lowering the free end of the bridge. The propeller is so designed that no vertical motion can be imparted to it by the swell, and cause difficulty in removing the bridge from the abutment. The time for opening the draw is estimated at 2½ minutes. The total estimated cost of the bridge is $108,000.

Robert E. McMath & Sons.—The design proposed by Mr. F. M. McMath, of Robert E. McMath & Sons, Consulting and Civil Engineers, St. Louis, Mo., consists of two separate swing bridges, each 244 ft. long, and arranged as shown by the illustration. The structure is designed with a 24 ft. roadway and 7-ft. sidewalks, on a lower deck, and with a single track railway on an upper deck; the approaches to the roadway consisting of a fill 150 ft. long with a 4% grade, and the railway approaches consisting of an iron viaduct on a 1% grade.

The arms of the draws are made of unequal length, the shore arms being made two panels shorter than the canal arms, so as to lessen the land area required. The short arms are counterweighted so as to balance the long arms when the bridge is open. When the bridge is closed, the ends of the short arms are latched down to the end piers, so as to resist the uplift due to a full live load on the canal arms, the shore arms being unloaded. The ends of the canal arms are latched together, at bottom chord joints, so as to prevent the deflection of one arm below the other under the varying conditions of loading.

The turntables are rim-bearing. Each draw is provided with hydraulic machinery for turning and for operating the latches. There are also all necessary arrangements for turning the bridge by hand power in case of accident to the hydraulic machinery. The machinery is designed to unlatch the ends, and open the draw in not to exceed one minute's time. The operating valves are arranged so that either or both draws can be operated by one man from one engine house.

The principal advantages claimed for this design are: rapidity of operation and the separation of the street and railway traffic. The total estimated cost of the bridge, exclusive of approaches, is $190,000.

J. A. McNicol.—The design presented by Mr. J. A. McNicol, of Providence, R. I., provided for a sliding draw consisting of two arms of equal length, entirely disconnected with each other, supported by a tower. The supporting tower is entirely separate from the two arms except at the top, where the tension members are connected by sliding nuts to machinery for raising and supporting the arms while the bridge is being rolled back. This tower is sufficiently rigid to take all unequal loading of the arms and also to transmit the top tensile strain if necessary. In the tower are placed all the machinery for operating the bridge. The advantages claimed for this design are: that no hydraulic platforms are required to raise and lower the arms; the arms are independent spans so that there is no kicking up of one while the load is on the other, and the strains are easily and absolutely determined. The time required to open the draw is estimated not to exceed five minutes. The total estimated cost of the bridge is $125,000, exclusive of substructure.

John N. Ostrom and Thos. E. Brown, Jr.—The design presented by John N. Ostrom, of New York city, for which Mr. Thos. E. Brown, Jr., of New York city designed the hydraulic lifting machinery, was for a double lift drum, consisting of two channel arms each 127 ft. long c. to c. of bearings, and two shore arms each 95 ft. 3 ins. long c. to c. of bearings. It provides for one roadway 20 ft. wide carrying two electric street car tracks and the general street traffic, one single track steam railway, 14 ft. clear width, and two sidewalks each 5 ft. wide. Each channel arm is supported at the abutments by a hinge and at the center of the canal by swinging piers resting in sockets in a pedestal in the canal bed. The shore arms support the hydraulic machinery for operating the draw. To open the draw each channel arm revolving on the abutment hinge is drawn backward and upward by hydraulic cylinders operating through the common method of a connecting rod and working beam. When released the arms descend by gravity; the rate of movement being controlled by the hydraulic cylinders.

As will be seen, a very important part of the bridge is the hydraulic machinery for its operation. In brief, this consists of two sets of three hydraulic cylinders and air accumulators, and one set of boilers, pumps and the necessary appurtenences to operate both sets of cylinders. One set of cylinders is placed on the top of the shore arm on each side of the canal and the pistons of each set are connected to a traveling girder, which in turn is connected with the working beams attached to the channel arm of the bridge. Power is supplied by two 50 HP. boilers operating two Worthington compound duplex pumps; one to operate each arm, and so arranged that the power of both may be combined to operate one arm in case of necessity.

With this machinery the arms of the draw can be operated separately or together; the time required to open or close the draw being from 1½ to 3 minutes. The operating force required consists of an engineer and fireman. The advantages claimed by the designer for this bridge are: rapidity of action; simplicity of design; adaptation for variable heights in vessels; economy in operation and the avoiding of false works in its construction. Its cost was estimated at $125,600.

Oscar Sanne and W. H. Finley.—Messrs. Sanne and Finley, of Milwaukee, Wis., submitted a design for a single sliding draw with a channel arm 261 ft. long, and a counterbalance shore arm 145 ft. long, and a movable trestle approach. At the main pier the bridge rests on a nest of 27 steel rollers 3 ins. in diameter and 16 ins. long, upon which the weight is equalized by means of coiled springs, two sets to each wheel. These rollers run on a track consisting of rolled steel rails weighing 104 lbs. per yard, carried by cross ties and longitudinals supported by cross caps on the tops of the foundation piles. Each roller is carried by three rails. To operate the bridge the approach is moved to one side and the bridge proper rolled back. The time required to open the draw is estimated at three minutes under the worst conditions. The cost of the bridge complete, including approaches, is $140,000.

Sooysmith & Co.—The design, submitted by Sooysmith & Co., of New York, was for a double sliding draw. The two skeleton diagrams, one showing the bridge closed and ready for traffic and the other showing the structure open so as to give the full width of the canal, clearly indicate the main features of the design. The structure is coupled at the center line of the canal with large pins of phosphor-bronze, which are moved by a screw gear actuated by a steam engine under the central part of each half of the bridge, and are driven into closely fitting pin holes in the heavy steel jaws of the chords. To open the bridge, these pins are first withdrawn, thus dividing the structure at the center line of the canal. Each half is then rocked or revolved through a small angle in a vertical plane about the large pins underneath the nests of four rollers near each bulkhead, and is then drawn backward by means of a winding engine and cables passing over fixed sheaves underneath each end of the bridge near its junction with the roadbed of the railway. The group of three rollers shown about half way between the central group of four rollers and the end of the bridge receive the track on the bottom of the lower chord of each half of the structure at the beginning of the retreating motion. The track on which these groups of rollers travel rises a little more than 2 ft. from the bulkhead to the end of the structure. Each shore arm of the bridge has a rising grade at the rate of 1% from its extremity to the main central posts over the bulkhead. The grade between the bulkheads of the canal is level. By this arrangement all floor beams and other portions of the bridge pass clear over the railway track at the point where it adjoins the bridge at each end. Heavy steel angle guides on each side of each of the four tracks on foundations compel all groups of rollers to move over their paths in an absolutely straight line, and similar guides upon the upper tracks compel the same exact motion of the superstructure when it is in progress in either direction. When the bridge is closed its extremities are held at the right level and in the right line by heavy locking arrangements. These locking arrangements are actuated coincidently with the entrance of the phosphor-bronze pins into the steel jaws. Each half of the structure is counterbalanced by a weight moving up and down the incline track, so that the duty of the engines is to overcome friction only.

By means of this structure and its machinery arranged to accomplish the purpose indicated, the canal can be either made free and open for navigation, or made to furnish a continuous bridge structure, for the passage of railway and wagon traffic, without occupying any land or space outside of the right of way of the railway track and necessary width for the highways. The total cost of the bridge ready for traffic, will vary from $140,000 to $190,000, according to the height at which it is placed above the water in the canal.

J. A. L. Waddell.—Two entirely different designs were submitted by Mr. J. A. L. Waddell, of Kansas City, Mo. The first of these designs, and that from which the Board of Public Works recommended the bridge to be built, was for a vertical lift bridge consisting of a simple truss span 200 ft. long so constructed and supported as to allow of being raised vertically to a height of 140 ft. above the surface of the canal. At each end of the movable span is a tower 170 ft. high, carrying at its top built steel pulleys about 15 ft. in diameter. Over these pulleys steel wire ropes, or chain cables, pass. One end of each cable is attached to the end piers of the trusses, and the other end to counter-weights which exactly balance the dead weight of the span. The only work left for the operating machinery is, therefore, to overcome the weight due to dirt, water, snow, etc. The power for operating the bridge is supplied by two electric motors placed at mid-span; the upward and downward motion being regulated by racks and pinions communicating with the power by means of steel shafting and spur and mitre wheels. The total weight of the bridge and machinery to be lifted is 500 tons, and the time required for raising and lowering the span varies from two to five minutes according to the height. In case the machinery fails the span can be raised by hand power. The substructure for the bridge consists of masonry piers resting on pile foundations. Its total cost is estimated at $125,000.

The second design was for a double sliding draw consisting of two shore arms and two channel arms. To open the draw each half of the bridge is rolled back inshore on steel rollers traveling on a cast iron track supported by masonry. To admit of this movement the trestle approaches, 130 ft. long, on each side of the canal, are moved sidewise about 50 ft. The time required to open the draw, including that for moving the trestles, is estimated at from four to seven minutes. The design provides for either steam or electric power operating by means of shafting and the necessary racks, and spur and mitre wheels. Separate machinery is used to operate each half of the bridge. Each shore arm has a counter-weight of concrete and is anchored to resist the uplift of the load of the channel arms. The channel arms are locked at the center of the span when the bridge is in use. The advantages claimed for the design are: reduction of time of operation about 40% and a possible saving in first costs. The total estimated cost is $154,000.

PERSONALS.

Mr. A. C. Bean, Roadmaster of the Central Vermont R. R., died last week at South Royalton.

Mr. T. W. Tracy, of Springfield, Ill., has been appointed President of the Ohio & Mississippi Ry.

Mr. W. C. Fulham has been appointed Assistant City Engineer at New Orleans, La., under Mr. Brown, City Engineer.

Mr. C. C. Chandler, Chief Engineer of the Ohio &

Mississippi Ry., has resigned, and has been succeeded by Mr. L. C. Fritch.

Mr. Ira S. Schrop, Superintendent of Water-Works at South Bend, Ind., has resigned, and Mr. John Graham has been elected to succeed him.

Mr. P. H. Baerman has tendered his resignation as engineer of the construction of the new village waterworks at Mechanicville, N. Y.

Mr. M. D. Cowden, City Engineer, of Harrisburg, Pa., was injured in the collision on the Philadelphia & Reading R. R., Oct. 24, particulars of which are given in another column.

Mr. E. M. Holbrook, C. E., who was injured by the bursting of a fly-wheel in the Brush Electric Light Works, at Niagara Falls, N. Y., Oct. 16, has died from the effects of his injuries.

Mr. Henry G. Eddy, for many years Superintendent of Repairs on the Illinois & Michigan Canal, died at his home in Lockport, Ill., Oct. 18, from the effects of an injury received Oct. 12 while superintending dredging repairs near Seneca on the line of the canal.

Mr. John. A. Potter, General Superintendent of the Homestead Mills of the Carnegie Steel Co., has been appointed Chief Mechanical Engineer. Mr. Charles H. Schwab, General Superintendent of the Edgar-Thomson plant, will succeed Mr. Potter at Homestead.

Mr. F. R. F. Brown has been appointed Mechanical Superintendent of the Intercolonial Ry. He has been Assistant Superintendent of the Grand Trunk Ry.; Mechanical Superintendent of the Canadian Pacific Ry.; Manager of the Dominion Bridge Works at Lachine, and recently Manager of the Toronto Bolt Works.

Mr. H. J. Pauling, M. Inst. C. E., Chief Engineer of the Cape Government Railways from 1884 to 1891, and engineer in charge of the construction of the western system of railways in Cape Colony, died recently in South Africa; he was an Englishman, and had been engaged in railway work in Denmark and Ireland.

Mr. F. H. Brydges, Second Vice-President of the Manitoba & Northwestern Ry., has resigned, and the position has been abolished, and Mr. W. R. Baker, formerly General Superintendent and Treasurer of the Manitoba & Northwestern Ry., has been appointed General Manager. Mr. D. B. Hanna will succeed Mr. Baker as Treasurer.

Mr. W. A. Stevenson, Superintendent of the Seneca Division of the new Buffalo line of the Lehigh Valley R. R., from Sayre to Manchester, has been assigned to other duties, and the jurisdiction of Mr. T. H. Fennell, Superintendent of the Buffalo Division, has been extended over it. This will give Mr. Fennell supervision over the entire line from Buffalo to Sayre.

Mr. John P. O'Donnell, C. E., M. I. M. E., of London, England, whose paper on "Railway Signaling," read at the American Society of Civil Engineers, is noted elsewhere, has accepted the position of Consulting Engineer for the National Switch & Signal Co., of Easton, Pa., and the company has acquired the American patents upon several of Mr. O'Donnell's appliances connected with signal and interlocking plant.

Mr. Peter Dorsch, who for many years was identified with the New York Central R. R., as Division Superintendent, under the administration of the late Chauncey Vibbard, died at Brooklyn Oct. 15. In March, 1862, he was appointed by the Government to superintend all railways which might come into possession of the Government. In 1866 he was Superintendent of the Southern Minnesota railroad, and his last service was as General Manager of the Albemarle & Raleigh R. R. of North Carolina.

Mr. Charles Stiff, Superintendent of the Hamilton Division of the Grand Trunk Ry., has resigned, and the staff at Hamilton, Ont., and Allandale, Ont., have been dismissed on account of the centralization of all office work at Montreal. Mr. James Stephenson, at present Superintendent of the Northern & Northwestern Division, with head offices at Allandale, will have charge of the entire road from Niagara Falls to Detroit and Port Huron, including the management of the Sarnia tunnel and international bridge.

Mr. Moritz G. Lippert, Assistant Engineer and Chief of the drafting department of the Phoenix Bridge Co., at Phoenixville, Pa., and his wife, were among the victims of the collision on the Philadelphia & Reading R. R., Oct. 24, which is noted elsewhere. Mr. and Mrs. Lippert were near the front end of the car which was telescoped by the smoking car. Both were pinned fast by a load of car seats and human beings while the fire began slowly to make its way toward them, but they were fortunately rescued alive. Both were seriously injured, but their recovery is hoped for.

Mr. Ralph Modjeski has opened an office as bridge engineer at 218 La Salle St., Chicago, Ill., and will make a specialty of the designing, inspecting and building of bridges, viaducts and other metal structures, and also of inspecting material at the mills and shops. Mr. Modjeski is a graduate (first diploma) of the Ecole des Ponts et Chaussees, of Paris, France. He was formerly with Morison & Corthell, and later with Mr. Geo. S. Morison, as assistant engineer, chief draftsman and chief inspector of superstructure on several large bridges, including the Memphis bridge.

Mr. Chas. Stiff, having retired from the position of Superintendent of the Southern Division of the Grand Trunk Ry., Mr. Jas. Stephenson will assume the duties of Superintendent on the system east of the Detroit and St. Clair rivers, with headquarters at Montreal. Mr. W. R. Tiffin will be Assistant Superintendent of the Western District. Mr. D. Morice will be Assistant Superintendent of the Central District. Mr. J. Webster will be Assistant Superintendent of the Northern District, and Mr. J. M. Riddell will be Assistant Superintendent of the Eastern District. Mr. Edmund Wragg will, on Nov. 1, be placed in charge of construction of the new station at Toronto, and Mr. Stephenson will have full charge of the company's operations in and around Toronto.

SOCIETY PROCEEDINGS.

ENGINEER'S SOCIETY OF PHOENIXVILLE.—The first regular meeting was held Oct. 18, Mr. W. Halliburton in the chair. This being the first regular meeting of the society, the only business was the election of officers for one year, which resulted as follows: President, Samuel T. Wagner; Vice-Pres., H. H. Quimby; Secretary, W. Halliburton; Treasurer, Chas. Scheidl; Chairman of Board of Directors, A. J. Leschorn. The society opens with 28 charter members.

ENGINEERING ASSOCIATION OF THE SOUTH.—The October meeting was held at the Association headquarters, Nashville, Tenn., Oct. 13, Vice-Pres. F. P. Clute, of South Pittsburg, Tenn., presiding.

Mr. Frank Cawley, of Montreal, Canada, read a paper on "The Mining Interests of Nova Scotia." The paper presented a very full and interesting account of the mineral resources of the province, the extent to which they are developed, the facilities for shipping at the several mines and harbors, and an exhibit of the amounts of the exports of several staple minerals to the United States for several years past. Mr. Cawley presented from the official reports of the province the following three analyses of coal, which are a fair indication of the coals of Nova Scotia:

Composition.	Pictou District.	Sydney District. Slow coking.	
	(1)	(2)	(3)
Moisture	2.10%	0.35%	0.75%
Volatile combustible	29.20%	32.85%	28.48%
Fixed carbon	61.15%	61.90%	66.38%
Sulphur	0.50%	1.15%	1.50%
Ash	7.55%	4.81%	4.18%
Specific gravity	1.28%	.....	1.29%

Mr. Thos. Sharp, of Nashville, then presented a paper on "The Spathic Ores and Iron of Lawrence Co., Tenn." The author stated this to be the only deposit of this ore in the South; and the only one making a successful grade of foundry iron, it being used, however, in a number of cases for steel making in Europe. The paper gave reports showing that the character and behavior of the iron in foundry practice was the opposite of what the chemical analyses and the fracture would indicate, the reported analyses and fracture indicating a mottled or white iron, while the foundry results showed it to be soft and fluid, making a strong and tough casting with a low shrinkage.

The third annual meeting of the association will occur at Nashville, Nov 10, when the president's annual address and the annual reports of committees will be presented.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting on Oct. 19, Mr. Chas. B. Brush in the chair, the Secretary read the paper by Mr. Saabye on "Construction of a Cheap Dam Across the Roanoke River near Salem, Va.," noted in our issue of Oct. 13.

Mr. J. P. O'Donnell, M. I. M. E., the English signal engineer, then read a paper on "Railway Signaling," which he had been invited to present to the Society. Mr. O'Donnell referred to Col. Haines' paper on standard rules for the movement of trains under the block system, which was published in our issue of Oct. 13, and he also described in detail the track and signal arrangements and methods of operating at the Waterloo terminal station, in London, of the London & Southwestern Ry., which is the largest plant in the world, and was described and illustrated in our issue of June 23, 1892. Only four men are employed in the main "A" signal cabin at the terminal during the busy hours. The system of interlocking tappets was first introduced by Stevens, of Glasgow, about 1874, and is practically the same as that now used, except that while the movement of the lever was first used to effect the locking, the preliminary motion of the latch rod is now more generally preferred for the purpose. A general system and set of rules should certainly be adopted to secure such uniformity as is secured by the rules of the Board of Trade in England. He also referred to the value of the investigations and published reports made by the Board of Trade on all railway accidents. The union of the lock and block system, as carried out in England, almost absolutely prevents collisions, except in cases of willful disregard of signals. He entirely disapproved of the automatic system of the signaling of stretches of main track. For switching out on a wrong track, a special authority is required in England, except at Waterloo and some other large terminals, where special signals are provided to govern such movement, and at Waterloo an automatic torpedo signal is used to indicate when an engineman runs past this special signal. (Eng. News, June 23, 1892.) Distinctive signals are also provided at that station to indicate whether a passenger movement, inswitching or outswitching movement is to be made. There are six main tracks approaching the station and the interlocking plant is so arranged that three trains can enter and three trains go out, all at the same time. Safety is provided for by the interlocking, and not by flag, the hand signaling being abandoned entirely. We may note here that hand signaling is employed at the Central Station (terminal) of the Caledonian Ry., at Glasgow, Scotland, where there is a very heavy traffic of local and main line trains (Eng. News, June 20, 1891). A little way beyond the trainshed is the main signal cabin, and in front of it a man is stationed on a platform between the tracks. He observes the movement of the signal arms and by whistling and hand signaling directs the enginemen to run in, back out, run into a sidetrack, etc., which is a very awkward way of handling such traffic.

In answer to a question by Mr. J. F. Crowell, as to the use of automatic signals on the open track in England, Mr. O'Donnell said that an electric automatic system, using the primary current, had been tried on the Freshwater Railway, on the Isle of Wight, but after some months' service it had been ordered out by the Board of Trade. Further experiments with a system of the same character, but using the Timmis system with secondary current, are to be made on the electric elevated line of the Liverpool Overhead Ry.

Mr. H. G. Prout said that in regard to the economy in the number of levers effected at the Waterloo station, such economy had been arrived at here, and the claim made that the same work could be done with fewer levers here than in England, by causing one lever to move two switches, or to lock, move and unlock in different parts of its stroke. He thought, however, that signal engineers here were overloading the levers and overdoing the economy. Mr. O'Donnell said that the Board of Trade requires separate levers for locking and operating. Selectors on the ground do overload the levers, but those at Waterloo are placed in the signal cabin, under the tails of the levers. The Board also requires the use of wires for signals, and the balancing of blades so as to normally bring them to the danger position. About 65 or 70 lbs. is generally used for balancing. The engineman is considered a part of his engine and must not use discretion, but must implicitly obey the signals. This is the best way to insure efficiency in operation.

Mr. O. F. Nichols said that in this country the work is largely done by the engineers of the several signal companies, who favor special systems, and a difficulty in securing uniform practice is that there are three or four systems of interlocking thus being introduced. Mr. O'Donnell said that the Board of Trade does not care so much about the appliances used, but demands that the required and specified results must be obtained. He pointed out the anomaly of the distant signal, which may be passed at "danger" and is really only a caution signal. If the distant signal is at "track clear," it indicates that the home signal is also at "track clear," but its "danger" position does not indicate the position of the home signal. Mr. Prout said that in this country a green blade is generally used for the distant signal, and this Mr. O'Donnell thought good practice, as the distant signal should be distinctive both by day and night.

Col. Haines said that his paper, read before the Railway Association (Eng. News, Oct. 13 and 20), was not intended as the expression of an expert on signaling, but to point out the difficulties which the Committee encountered in preparing a standard uniform code of rules for the guidance of employees operating under the block system. Many roads in this country could not possibly find the money to put in such complete plant as required in England, and if this was attempted they would be forced into bankruptcy. It is only where there are many tracks and heavy traffic that the system can as yet be introduced. He was inclined to favor the automatic system, as eliminating some of the classes of accident due to human error, and reducing the cost. Interlocking and the operation of trains by the block system on the main line are two different things. A great difficulty in this country is the difference of codes of signals, and he strongly urged the necessity for uniformity. He also said that the permissive block system was used in England, but Mr. O'Donnell explained that this is only on such days as the Derby day and the Oxford and Cambridge race day, when the traffic simply could not be handled under the absolute block system, and the system is therefore suspended, though without authority. Such a practice,

however, is in the interest of the shareholders, and not in that of the traveling public. The distance between home and distant signals in England is 2,400 ft. on the level, or 3,600 ft. on down grades. The single wire system is used; no double wires being used in England. Mr. Theodore Voorhees said that on the New York Central R. R. the single wire system has not been found to work well, and has been abandoned for the double wire system, the distance being limited to 1,000 ft.

Mr. Grant referred to the pneumatic-automatic system in use on the four track line of the Central R. R. of New Jersey, between Jersey City and Elizabeth, 30 miles, with eleven sets of interlocking plant. The system is carefully looked after, and maintained in the same way as the track, by a special gang. The main cabin governing the twelve tracks of the Jersey City terminal station has 72 levers. The signal plant and terminal station were described in Engineering News, March 29, 1890, and Oct. 6, 1888, respectively.

Mr. Voorhees, referring to the increase of fast and heavy trains on trunk lines, and the difficulties in stopping, asked what should be done to protect such a train with a train stopped on the track in front. They had tried the automatic slot back to the next signal, but had not found it successful, and he did not think there was a successful apparatus of this kind in use here. Mr. O'Donnell said that the slot system had been used successfully with the heavy traffic at Waterloo. Mr. Voorhees also said that he had been largely instrumental in getting the pneumatic block plant put in between Mott Haven and Woodlawn, but found that it could not be worked under any absolute rule, it being necessary to provide that enginemen could pass the signal when at "danger," after waiting a certain time interval. For this reason the New York Central R. R. has adopted the Sykes system between New York and Buffalo, which work is now under contract.

Mr. O'Donnell advocated the English plan of having a separate post and arm for each track, but Mr. George R. Hardy preferred the arrangement of the two arms for through roads on the same post, with a separate short post and arm for the crossover. Mr. Prout, however, said that in this country the best practice is tending toward the use of a separate post for each blade, as being more distinctive to the engineman. Mr. Bradley, referring to the difficulty of getting enginemen to properly observe and obey signals, said it might be necessary to extend the system so as to interlock the engineman. Mr. Hardy also referred to the system on the Boston & Albany and Old Colony railways, where two lights in a horizontal line indicate the stop position, and two lights in a vertical line the safety position. On the B. & A. R. R. the colors are two white and two green lights, respectively; while on the O. C. R. R. the colors are two red and two white lights, respectively.

There was a large attendance, and the discussion was unusually brisk, bringing out the fact that American railways have yet very much to do to bring their signal equipment up to the desirable standard of efficiency, and showing very strongly the disadvantages of the present inconsistent codes now in use, and the necessity for arriving at some uniform code of rules and regulations, which is the aim of the committee of the American Railway Association. At the close of the meeting a cordial vote of thanks was tendered Mr. O'Donnell for his very valuable and interesting paper.

AMERICAN STREET RAILWAY ASSOCIATION.—The eleventh annual convention opened at Cleveland, O., Oct. 19. The members were welcomed by Mayor Wm. G. Rose in a witty address, in which he referred to the false reports concerning the dangers of the overhead trolley wires in Cleveland, which had been recently published in the New York dailies, and said:

> I have ridden on the trolley cars of the East Cleveland Co. on Prospect St. three or four times nearly every day for a year and a half, and I have not yet seen a man, woman, child or horse killed or injured by the trolley wires. I have heard of several horses being killed, in various parts of the city, by the breaking of the trolley feed wires, and I have also heard of a number of persons who have been killed or injured by the electric light wires, traceable in every case to faulty construction, but I do not now remember of a single instance where a human life has been lost by reason of the trolley wires.
>
> It is true that accidents often happen and a good many persons have been killed or injured by the rapid running of the motors, but not more, perhaps, in proportion to the amount of travel, than occur by the steam railroads or by any other method of rapid transit. Many of these accidents could be prevented by placing proper guards over the wheels and by proper care on the part of the motormen by slowing up and ringing bells at all crossings.
>
> Another fruitful source of accidents is the employment by the companies of green men to run motors. No man should be placed in charge of a motor until he has passed an examination by an experienced electric motor engineer and has been licensed, the same as locomotive and stationary engineers. Laws should be passed compelling the companies to adopt such regulations.
>
> I am opposed on general principles to overhead wires; they are often an obstruction to the effective working of the fire department; they are unsightly and more or less dangerous, and as soon as possible they should all be placed in conduits under ground. But no practical method has yet been devised for running motors by underground wires, and until that time arrives I would rather bear the ills we have than to go back to the barbarous system of horse cars.
>
> If it were put to a vote to-day in the city of Cleveland, there would be twenty to one in favor of the electric or cable system. The noise of electric cars on resident streets is a great annoyance, but it can be overcome in a great measure by improved methods of gearing. The use of electricity as a motive power is yet in its infancy, and it is only a question of time when all these desirable improvements will be accomplished. . . . .
>
> The tabulated statement in "Electrical Industries" of October, 1892, shows that there are in the United States 469 electric roads with 5,446 miles of track, using 7,709 motor cars and 3,790 trail cars. There are now in operation in Cleveland about 50 miles of double track electric street railways and 16 miles more of double track in process of construction, which, when completed, will make a total of 132 miles of track using the trolley system. We have also one of the best constructed cable roads in the country, operating 11 miles of double track. This road is splendidly equipped with all the most modern improvements known to the cable system. Including horse car lines, there are altogether about 175 miles of street car tracks in Cleveland. . . . .You are fast taking harness off horses and putting them on lightning and steam. The words "grip" and "wire pulling" have received from you a new and enlarged meaning. You propose to divide the use of the streets with the people, but you take your half out of the center. You ask a right of way through the principal thoroughfares, and, when it is granted, the right to keep out of your way is the only valuable right that remains. . . . . You often obtain franchises, as in this city, worth millions of dollars, without paying for them one penny into the city's coffers. But who is to blame for it? The municipal legislature. And who is to blame for the municipal legislature? The people who elected it. In Ohio you have appealed to Caesar. A bill is now pending in the legislature of this state to extend, for a mere nominal percentage of the gross receipts, all street railway franchises for a period of 99 years. Gentlemen, this is a mistake. You are asking too much. The legislature that will enact such a law will be doomed to eternal infamy. If you persist in such demands, the time will soon come when municipalities will own and operate all street railways the same as they now own and operate water-works and in some places gas plants.

President Jno. G. Holmes, in his address, said:

> The street railway interests of the United States are assuming wonderful proportions. Every day some new company is born, and every morning paper brings us rumors of consolidations, absorptions and syndicate purchases, until the statistician lays aside his pencil and sheet in despair, utterly bewildered by the mass of accumulating and shifting figures.
>
> This is pre-eminently an electric age, and most of us believe that as yet we are only standing on the threshold. The horse and his half brother, the mule, are destined to disappear. The cable system, from its very nature and cost, must be confined to the thickly populated districts of large cities, but there seem to be no limitations to the electric railway. It leaps over the city lines wherever there is a large suburban town calling for rapid transit; it girds the summer lakes; it is forcing its way through the scenic splendors of the Niagara gorge, close beside the water's edge, and when the convention goes to California, as no doubt it will some day, we may expect to ride around the Yosemite on a train of trolley cars.
>
> And how rapidly it has all come about! It was just 10 years ago that the president of this association, at the Chicago meeting, with a foresight which must have been born of intuition, ventured to predict that the lightning would some day be harnessed to the horse car. We laughed at his visionary prophecy, and dismissed it from our minds as a piece of optimistic nonsense. But the prophet of a decade ago is with us to-day, and can take revenge by saying, "I told you so."
>
> So accustomed have we become to rap'd strides and the complete overturning of the existing order of things in our business, that I do not believe that one among you would venture a doubtful smile were I to assert that before the close of the nineteenth century the three successive convention cities, Buffalo, Pittsburg and Cleveland, will be joined together by a triangular electric belt line, with an immense power house at Niagara Falls, where they are even now just on the point of developing 160,000 HP.
>
> But this is an assembly of practical men who have come together, not to vie each with the other in making extravagant predictions, but rather to contribute each to a common fund the results of his observation and experience. The congestion of traffic in our business centers, the increasing throngs of passengers of the working class, nights and morning, as the day of tenement houses gives way to the age of suburban cottages, the safeguards against accidents required by the exigencies of rapid transit, the labor question, the unjust and burdensome taxation of corporations, the ways and means of increasing traffic and reducing the cost of maintenance and operating expenses, give us plenty of subjects for discussion.

The Executive Committee reported that it had purposely in preparing the program for the meeting aid chief attention to questions in connection with electric roads; and congratulated the Association on the prosperous outlook for street railway companies. The treasurer's report showed total receipts of $7,514 and expenses of $6,049, leaving a balance of $1,524 in the treasury.

The first paper on the program was by Mr. D. F. Longstreet, General Manager of the West End Street R. R. of Denver, Colo., and was of historical interest only, describing the formation of the Association. Next came the report of the committee on "A Model Electric Street Ry, Roadbed and Underground Wiring." At the evening session a long discussion took place on this paper. We reprint both the paper and the discussion in another column. Following this came the report on "A Perfect Overhead Electric Construction," which we shall publish later. The evening's exercises were concluded by the appointment of the following committee to consider the establishment of a permanent exhibition of street railway inventions and supplies: H. C. Payne, Milwaukee; D. F. Longstreet, Denver; O. T. Crosby, Boston; Wm. Wharton, Jr., Philadelphia, and H. A. Everett, Cleveland.

Wednesday afternoon was devoted to an excursion to the works of the Short Electric Ry. Co.

At Thursday morning's session the Committee on "Economy of Machine Shops for Electric Street Railways," Mr. John H. Bickford, presented a report favoring on the whole the establishment of such shops. The following is an abstract:

Previous to the introduction of electricity our street railways were conducted with inexpensive labor, and we have come to look on this method as the only truly economical one. But now we have equipped our cars with delicate machinery, have put complicated mechanism in our power stations, and have obstructed (so the public say) our highways with a multiplicity of wires. It would be the height of folly to place this apparatus in the hands of men who do not understand the first law of mechanics, yet I am sorry to say that this was done on roads in the early days of electric traction.

We must have skilled mechanics to repair and care for our electric machinery; and, to do their work properly and economically, they must have suitable tools and machinery. The question arises, however, how far shall we carry the equipment of the machine shop. Is it best, if we go as far as to establish a shop for repairs, to go a little further and manufacture supplies?

We may, to a certain extent, be guided by the practice of steam railways. These we find have complete repair shops, and they manufacture a great many supply parts, even cars and locomotives. Although the manufacture may cost a trifle more in some instances than the thing made could be bought for, if it will give better service it may still be more economical.

To ascertain the prevailing practice on street railways, a circular letter was sent to over 250 electric roads and 66 replies were received. Of the roads replying, 24 are maintaining machine shops, doing all their own repairs and manufacturing many supplies. They state that they can make better articles than they can buy; that they are perfectly familiar with the requirements and conditions of the business, as they are operating the roads and are in a position to know just what is needed, and are better able to judge of the strength and durability of the apparatus than those who have never been in a similar position.

They further state that there is a saving of 25% to 50% in manufacturing instead of buying supply parts.

The following is a classification of the answers received, based on the number of cars operated:

Cars operated.	Number of roads reporting.	Machine shop. None.	Partly equipped.	Fully equipped.
10 or less	16	14	2	..
10 to 20	13	6	7	..
20 to 30	10	4	.	6
30 to 50	6	1	3	2
50 or more	12	..	2	10

One of the roads operating 50 or more cars maintains, besides its repair shop, an extensive manufacturing establishment, including a brass foundry. The nine others in the class, as well as all roads which maintain fully equipped machine shops, reported that they manufactured many parts for renewals.

Of the 66 roads, 36 wind their own motor armatures and field coils. The cost of armatures varied from $17 to $75. The average was about $35, including all labor and material. Wood-working machinery, consisting generally of saw table, bandsaw, planer and mortiser, was reported by 15 roads. Seven roads cut their own gears, but some found it no cheaper than to buy. Eight roads build cars, while several others rebuild old cars. The following is an average cost at which supply parts are being made on eleven different roads using Sprague, Thomson-Houston and Westinghouse motors with double reduction gearing:

Refilling commutator (copper bars)	$18.50
Two halves armature bearing, T. & H., $5.90, single Sprague	1.85
Two halves axle bearing	3.50
Brush holder	1.35
Rocker arm, T. & H., $1.00, Sprague	3.00
Intermediate shaft (steel), T. & H., $10, Sprague,	3.00
Intermediate pinion (steel)	4.20
Intermediate gear	3.88
Axle gear	5.06
Armature pinion (steel)	3.58
Trolley wheel (brass)	1.06
Line frog	1.90
Clips for line hangers (brass)	.15
Boring and pressing on 30-in. wheel	.95

With but two exceptions, the roads reported the

single-reduction motor as costing least to maintain. An electrical engineer is employed by 19 roads, and 4 others have an electrical engineer as Superintendent.

Mr. Payne said there was no doubt that practical results in the operation of an electric road came from economy in the machine shop.

Mr. Wardwell, of Duluth, said the repair shop, if not properly cared for, would be the largest institution in connection with the road, and might contain four times the tools and machinery which were really necessary.

Mr. Lawless, of Paterson, said that there was no question that a machine shop on a proper scale was desirable for either an electric or cable railway, but the trouble is that once started it keeps on growing. It is astonishing how a good mechanic or machinist likes to get in expensive tools and equipment, and unless carefully watched, he will have a shop that could supply half a dozen roads.

Mr. Ramsey said that for the first three months of his road's operation all repairing was done outside, and the cost was so excessive that a repair shop was found a necessity. He drew the line at gear cutting, as no road of ordinary size could use gears enough to keep a gear cutter employed all the time. There had been a great reduction in the cost of supplies. Three years ago commutators cost $76; now they were made for $19.

Mr. Wason said that an important point in cheaply repairing motors was a convenient arrangements of pits. There is such a thing as having a pit too long, for it will generally be found that the car which requires only simple repairs, and which is first needed, is the last one in the line, and the others must be moved to reach it. The pits in his shops are four cars long; but only three cars are taken over each pit. He has a hydraulic lift running in the pit underneath the car, and has taken off two motors and put on two, and had the car running in 30 minutes. He has taken an armature out and put one in, and had the car running in 5 minutes. In having work done outside the shop, charges for cartage count up very rapidly.

The report of the committee on the comparative cost of operating cable and electric railways (reprinted elsewhere in this issue), was then read. Mr. Baldwin, of Cincinnati, said that it was found in that city that the cable roads were far cheaper to operate than electric cars over the same route. Repairs are the heavy item in electrical work, for it requires more than double the men to clean motors, and make repairs that are required with the cable system, and most of these are high-priced men instead of being ordinary mechanics. In heavy rain and snow storms it is impossible to maintain the same regularity of service on electric lines that is possible with the cable system.

A recommendation was made and referred to the Executive Committee, that a committee be appointed to ascertain the operating expenses of all the street railways in the country for presentation to the next meeting

Mr. Lawless said the sphere of the cable system was limited; but in that sphere it holds its own. There are districts where the cable railway can be operated more cheaply than any electric road. In computing the expenses on the car mileage basis, electric roads in sparsely settled districts are apt to show better results than those in the thickly populated portions. Where an electric car can run up to 20 miles per hour it can make about 150 miles per day; but in the heart of a city it can make only 80 to 90 miles. With the same wages per day, the suburban line will show much better results. Some three or four years ago the statistics showed rather in favor of the cable lines; but since the single reduction motors have come in, and the cost of repairs has come down, the electric line presses the cable pretty hard, even in thickly populated sections.

At the afternoon session on Thursday, the Committee on Standards reported on methods of accounting, dimensions of machinery and appliances, nomenclature, and the rating of motors.

On the first subject the committee emphasized the importance of keeping the accounts of transportation, maintenance and construction entirely separate. The car mile was recommended as the unit of operating expenses. In comparing motive power expenditures, double truck cars should be distinguished from single truck cars. It will be reasonably safe to rate a double truck car as two standard 16 ft. cars, as far as motive power is concerned, experience having shown that the consumption of power in the two cases is nearly equal under given conditions.

The subject of standardizing specific dimensions was investigated by Mr. C. V. Wason. He received replies to a circular letter of inquiry from 30 electric railways and compiled from them the following as the dimensions apparently most in favor as standards:

Car axles, diameter, 3½ ins.; wheel seat, 3⅛ ins.; journal, 3 × 8½ ins.

Car wheel: diameter, 33 ins.; weight, 350 lbs.

Trolley wheel: diameter, 4½ ins.; width, 1½ ins.; depth of groove when new, 1¼ ins.

Key-way for axle gear, ⅜ × 6 ins.

Gage of wheels, measured between hubs at the axle, 48 ins.

The railways from which the information was collected by which the above standards were compiled use possibly a lighter equipment than some which is now put on the market. The dimensions have been widely discussed, however, and meet with general approval. Besides the above, it was recommended by a large majority of the correspondents that a standard trolley wire should be adopted. Its size should be No. ° B. & S. gage, and it should be of hard drawn copper, with a conductivity 98% of the standard, and a tensile strength of about 55,000 lbs. per sq. in.

Concerning the rating of motors, an able discussion was presented by Mr. Oscar T. Crosby, of the committee. After discussing the many defects in connection with the present rating of motors by horse power, it was recommended that a standard system of motor rating be adopted under which a motor should be rated by the horizontal force which it can exert on a car at a speed of 10 miles per hour, the car being fitted with standard 33-in. wheels and such gearing being used as the manufacturer prefers. Thus for the present, a 600 × 10 motor would mean a motor which can exert a 600 lb. pull under the above conditions. As this method of rating becomes familiar the second term may be dropped and the motor would be known simply as a 600 motor. On the other hand, with the increase in the use of motors in high speed suburban service, ratings such as 500 × 20, 800 × 30, etc., may come into use, the second term expressing always the speed in miles per hour at which the rating is made.

It should be also understood that implied in this rating is the requirement that the motor shall be able to perform its rated work continuously without a rise in temperature exceeding 75° C. over the atmospheric.

Should the Association not see fit to adopt this rather revolutionary proposal, the committee recommended as their second choice a two-term rating for motors, the first expressing the horse power at which the motor can work continuously at a safe temperature, the other the maximum power it can exert. Thus motors would be rated as 15 × 35, 20 × 40, etc. In making either of these ratings a pressure of 450 volts is assumed as the standard, that being the pressure found on most electric railways throughout the country.

Finally the committee on standards recommended that the Association employ a salaried officer to give his entire time to the collection of data bearing on the Association's work according to the direction of its officers.

The Committee's first recommendation was adopted by the following resolution:

Resolved, That it is the sense of this Convention that the standard rating of railway motors shall be the horizontal pull which the motor can exert when running a car with 33-in. wheels at ten miles per hour, and that when so running, the temperature of the motor shall not be raised to more than 65° C. above the surrounding atmosphere after a ten-hour run.

The recommendation as to the appointment of a salaried clerk to collect railway statistics was referred to the Executive Committee.

The proposed formation of an association of dealers in street railway supplies was reported on adversely by the Executive Committee.

A communication was presented from the Massachusetts Street Railway Association, calling attention to the advantage of interlocking signals at the crossings of steam and electric railways. It asked that a circular be sent to every street railway company in America, and to the Railway Commission of every state, recommending legislation making the establishment of such interlocking signals obligatory. This was referred to the Executive Committee.

At Friday morning's session the papers on "The Expansion of a Continuous Rail," and "Is a Standard Rail Head Possible?" the first of which is published elsewhere in this issue, were presented by title only, and were not discussed.

The following resolution was adopted:

Resolved, That the American Street Railway Association sends greetings to the tramway managers and officers of the European and foreign countries, and most cordially invites them to attend the 12th annual meeting of the association, to open in Milwaukee, Wis., October 18, 1893, during the World's Columbian Exposition.

The following officers were elected, after which the association adjourned: President, D. F. Longstreet, Denver, Colo.; Vice-Presidents, A. Everett, Cleveland, O., Joel Hurt, Atlanta, Ga., W. Worth Bean, St. Joseph, Mich.; Secretary and Treasurer, W. J. Richardson, Brooklyn, N. Y.; Executive Committee: John G. Holmes, Pittsburg, Pa.; J. D. Crimmins, New York City; T. J. Minary, Louisville, Ky.; J. R. Chapman, Grand Rapids, Mich.; B. E. Charlton, Hamilton, Ont.

THE IRON AND STEEL INSTITUTE (From our London Correspondent).—The autumn meeting of this Society was held in Liverpool, Sept. 20 to 24. The sessions were held in St. George's Hall, and the President of the Institute, Sir Frederick Abel, occupied the chair. The meeting opened with the usual complimentary speeches, following which the president gave a brief address. The most interesting part of this was his description of the recent researches of Professor Dewar and Dr. Fleming, upon the electrical resistance of metals and their alloys. A few years ago M. Cailletet made some experiments in this direction, and produced his low temperatures by means of liquid ethylene (liquefied olefiant gas). A Russian investigator in this field, Wroblewski, made experiments of a like nature with wires of electrolytic copper. He used as his refrigerating agent nitrogen at its critical point (that is, the point at which it passes over from the gaseous to the liquid condition), at its boiling point, and also at the point of solidification.

These experiments of Continental investigators were conducted under many disadvantages; but Professor Dewar, of Cambridge, has lately been doing some remarkable work at the Royal Institution in London, by which he has placed at the command of physicists and chemists comparatively liberal supplies of a refrigerating agent capable of producing very much lower temperatures than have hitherto been feasible. The very large scale on which Professor Dewar has been able, by simple mechanical arrangements, to liquefy oxygen gas, has put a material at the disposal of experimenters which will enable them to carry their investigations as to the properties of substances at low temperatures to lengths which were not dreamed of a few years ago.

It is needless to enlarge here on the influence such an advance in scientific investigation may exert on the industrial arts, especially metallurgy, and through them on engineering practice. Happily, even the most conservative of manufacturers now recognizes that his processes are founded on scientific principles, and the above is an excellent example of the manner in which the professor may influence the producer.

Professor Dewar has been able to liquefy atmospheric air and to determine hitherto unknown properties of oxygen. Liquid oxygen, like gaseous oxygen, is highly magnetic, and is also a perfect insulator. It is, therefore, a simple matter to determine the rates of change of electrical resistance of different metals by taking them in the form of fine wires, and immersing them in a bath of liquid oxygen or a bath of boiling oxygen—that is, liquid oxygen exposed to the air and in ebullition due to the rapid passing away of the element in the form of gas.

Working on these lines, Messrs. Dewar and Fleming found that pure metals were divisible into two classes according to the rate of change of electrical resistance with temperature. Such metals as iron, nickel, copper and aluminum rapidly change their electrical resistance as the temperature changes, and the rate of change increases with the decrease of temperature. With another class of metals the very opposite is the case. The latter class includes gold, platinum and palladium.

One practical result of these discoveries is a new means of determining whether a metal be absolutely pure; and, if not, the extent, and possibly, the nature of its impurities. Thus, with perfectly pure metals the specific change, i. e., the actual change in electrical resistance at a low temperature, is very great indeed, until they become, comparatively speaking, conductors. With certain metals there appears to be no doubt that as the temperature falls to not very far from absolute zero, a metal which normally has considerable resistance becomes not only feebly resisting, but might become void of resistance, or reach the zero of electrical resistance.

The influence of small quantities of impurities upon this property was very remarkable. For instance, the electrical resistance of a pure iron wire at 100° F. is 23 times as great as when the wire is cooled down to—200° C., which was a temperature obtained by Professor Dewar. This result was altered to a remarkable degree by the presence of minute quantities of impurities in the iron. A specimen of so-called pure nickel was obtained, and this at 0° C. gave a resistance of 13,387 electromagnetic units. When it was cooled down nearly to—200° C., it was reduced to nearly half this resistance. That was the result obtained with nickel which was styled "pure"; but when a specimen of Mond's nickel was obtained which was absolutely pure, and it was exposed to 0° C., it gave a resistance of 12,000 units, whereas, when cooled down by means of liquid boiling oxygen to a temperature of—182° C., it only had 1,900 units of resistance.

The same was found with regard to wrought iron. This metal, as every one knows, has normally a much higher resistance than copper, but when cooled down to the extremely low temperatures to which reference has been made, it became actually the better conductor. Sir Frederick added a few words with regard to what had been done in the production of liquid oxygen. A few years ago much labor and uncertainty attended the production of two or three drops, but now Professor Dewar manufactures it by pints.

Sir Lowthian Bell then read his paper on the relation of iron making to agriculture. This contribution deals

with what promises to become a most important subject. It would be interesting to follow the author in his description of the manner in which plant life and animal life are interdependent, and Nature's great cycle of creation and decay is ever working round; but confining our attentions to the more practical part of the paper, it will suffice to say that sulphate of ammonia is the chief product which is reclaimed from blast furnace gases. At the works of Merry & Cuninghame, in Scotland, the most modern type of plant for this purpose is in use. It will, of course, be understood that only blast furnaces using raw coal can be utilized to make this product.

The plant consists primarily of dustboxes, condensers, exhausters and separators. In addition to these tar and ammonia plants are added for working up the recovered materials. The furnace gases are taken from the gas tube of the ordinary closed-top furnace, and enter the dustboxes, where the dust is deposited along with some 80% of the associated tar. The gas on leaving the dustboxes enters a condenser, consisting of 144 wrought iron tubes, 20 ins. interior diameter by 55 ft. high. The total length of piping is five miles, and it has an external area of about 48,000 sq. ft. The cooling is effected by water sprays. The condensed tar and ammoniacal liquor is conveyed into a separator, and then into the respective tar and liquor tanks. The temperature of the gas on entering the condensers averages 130° F., and on leaving it, 60° F. From the condensers the gases pass through the exhausters, the working of which is regulated by governors worked by the pressure of gas in the main gas-tube. From the exhausters the gas is forced into washers, which consist of four cast iron boxes sealed with the ammoniacal liquor itself. The overflow liquor from the washers is carried to the separator for dividing the tar and liquor from the condenser boxes, these two ingredients then passing to their respective store tanks.

The gas next passes forward into scrubbers, which consist of three towers, each 120 ft. high by 18 ft. in diameter. These towers are filled with thin boards, about 7 ins. wide, set on edge, each tier of boards being at right angles to those adjoining it. The gas enters No. 1 scrubber at the bottom, and in traveling to the outlet at its top meets the liquor which is pumped from the tank to a so-called distributor, revolving in the inside of the top of the scrubber, and causing the whole area of the scrubber to be equally wetted. There is thus presented a very large scrubbing surface for the gas to travel over. The gas then passes to the second scrubber where a similar process is gone through, after which it goes to the third tower, where clean water is used in order to arrest the last traces of ammonia. The washed gas deprived of its ammonia is burned in the hot air stoves and boilers at the ironworks.

The yield of raw products has averaged 120 gallons of ammoniacal liquor of 2° by Twaddell's hydrometer, and 25 gallons of tar per ton of coal used in the furnaces. The ammoniacal liquor is worked up into sulphate of ammonia by distilling with steam, the stills being heated by blast furnace gases which have passed through the condensing apparatus. The waste gas from the saturators, in which the sulphate of ammonia is deposited, is used for heating the liquor previous to its entering the ammonia stills.

The tar is distilled by another set of apparatus, but it is unfit for supplying the products used in the manufacture of aniline colors unless passed over red hot coke, when benzole and anthracene may be obtained. The author quotes figures with regard to the plant, above referred to, covering a period of three weeks, during which three furnaces were blown for a fortnight and four during the third week. The weight of coal consumed was 5,841 tons.

The following was the amount and value of the by-products:

Sulphate ammonia, 48 tons 8 cwt. @ £10. 10. 0	£508. 2. 0
Pitch, 361 tons, @ £1. 1. 0	379. 1. 0
Oil, 33,750 gallons, @ 1½d.	210. 18. 9
	£1,098. 1. 9
Paid wages, sulphuric acid, management, freight bills and allowance for depreciation of plant	379. 12. 3
	£718. 9. 6

According to these figures, the profit on the by-products from 5,841 long tons (= 6,542 net tons) of coal in the blast furnace was $3,590.

Nearly every blast furnace in Scotland now has an ammonia plant attached. American iron makers can apply the above figures to their own case by substituting the corresponding American values for the products quoted,* remembering, of course, the difference between British wages, railway rates, etc., and those of America. It must be said, however, that Sir Lowthian Bell appears to take a somewhat roseate view of the case.

The part of the paper in which Sir Lowthian explained the office of phosphorus in the development of the human race, and the value of the basic process, which produces a phosphoric slag, was very interesting. Twenty years ago an enormous loss was incurred by Great Britain from allowing the phosphorus of 20,000 tons of phosphoric acid to poison a pig iron product of 2,000,000 tons per annum. At the same time her ships were scouring the seas in search of phosphoric acid and were bringing it from the remotest parts of the earth. The author therefore rejoiced that we were fast removing this scandal from the manufacturing escutcheon of nations by the introduction of the basic process.

The next paper read was Roberts-Austen's contribution. It consisted of a description of an apparatus which he has designed for making an autographic record of the temperature of hot-blast stoves. A thermo-couple (platinum-rhodium) is used, as in the Le Chatelier pyrometer (described in Engineering News of Oct. 10, 1891). The novelty in the present apparatus appears to consist in throwing the spot of light from the reflecting galvanometer onto a sheet of sensitized paper wound on a revolving drum. The temperatures at several different points can be recorded in this way with a single galvanometer and recording drum, by switching off and on a number of couples in rotation. Of course the record for any one source of heat will not be absolutely continuous, but spots will be made through which the curve of temperature can be plotted, with sufficient accuracy. The change from one thermo-junction to another may be made by clockwork so as to make the machine entirely automatic. In the discussion which followed very general testimony was borne to the advantages of the pyrometer and the usefulness of such an apparatus as the author proposed.

Mr. J. H. Greathead followed with a paper on the Liverpool Overhead Railway, a line now fast approaching completion. It has already been described in these columns (Sept. 5, 1891; Jan. 30, 1892). A short review of the details not heretofore described will be found elsewhere in this issue.

The first paper on the second day was the paper on "Alloys of Iron and Chromium." Nothing like justice can be done to it in a report of this nature. Mr. Hadfield is one of the youngest and one of the most brilliant of our British metallurgists. The success he has achieved in the manufacture of chrome-steel projectiles has made the name of his firm famous throughout the world. Unfortunately for English manufacturers, Continental nations were allowed to creep ahead in this matter, so that some of our leading firms had to lean on foreign houses for assistance. It has been Mr. Hadfield chiefly who has helped us to retrieve our position, so that now Hadfield projectiles stand beside those of Holtzer.

Mr. Hadfield's paper is a generous gift to the metallurgical industry, for in it he gives the result of much arduous thought and many months of work, to say nohting of the money expended in carrying out experiments, the results of which he makes public. As is well known, chromium in steel acts as a hardener; but Mr. Hadfield points out that it is not a hardener per se, but probably acts in some manner by affecting the combination of the alloy of iron and carbon. The matter is somewhat obscure at present, one great difficulty being to determine the action of chromium as an alloy of iron apart from carbon, because as the carbon is reduced in the mass the chromium also disappears.

Although it appears invidious to make selection among the mass of facts Mr. Hadfield puts before us, we may perhaps quote details given in regard to the most surprising use to which chrome steel has been put. A 13½-in. chrome-steel projectile was fired from a 63 breech-loading rifle at Shoeburyness. The target consisted first of 20 ins. of compound armor, next a 6-in. wrought iron plate, next 20 ins. of oak timber, next 10½ ins. of wrought iron, and finally a 2-in. wrought iron plate. The striking velocity was 1,950 ft. per second, and the energy 34,280 ft. tons. The projectile, weighing 1,120 lbs., passed through the 36½ ins. of iron and steel, besides the timber, but was broken in the transit. Two 6-in projectiles, selected by the inspector from a large delivery for the British Government, both passed through a 9-in. compound armor plate, the only effect on the projectiles being in one case an increase in diameter of .011 in. and in the other a decrease of 0.210 in. Another 6-in. projectile was fired through two 9-in. compound plates consecutively, and broke up on being fired at a third plate.

There was a long discussion on this paper, but we cannot say that anything very material was added to our knowledge of the subject, although some of our best authorities took part in it; indeed, throughout the meeting, the discussions did not rise above a very mediocre level. Mr. Vickers started the old question of hardening, a process he supported, and Dr. Anderson followed. Probably the case may be briefly stated by saying that hardening by quenching is excellent for small pieces of steel, but is too risky a proceeding for large masses, in which the violent treatment may set up flaws or defects which are not apparent until the parts give out when placed under strain. Undoubtedly this has been the case with steel ordnance.

Mr. F. W. Webb, Locomotive Engineer of the London & Northwestern Ry., said that he used chrome-steel for all springs, and also very largely for tires, as it wore better than carbon steel. He had also used it for tool steel, and with only 0.65% of carbon, yet he found the tools gave excellent results.

Mr. Winder's paper on the failure in the necks of chilled rolls was a short but useful contribution. Every one knows how unaccountable is the behavior of chilled rolls, and how they will sometimes give out, one after the other, until one can at last be got to stand the work. Mr. Winder attributes the failures to the molecular change caused by the water poured on the necks to keep them cool in the bearings and prevent cutting. This of course is a necessary condition, for the rolls must get hot in the body when passing red hot metal, while the necks must be kept cold. Of course hollow rolls have been tried again and again, but apparently without success. Mr. Winder says the right thing to do is to make the change in diameter from body to neck as gradual as possible, so as to prevent localization of the field of change in temperature, instead of keeping it in one plane.

The last paper read on this day was by Professor Hele-Shaw, and described the Walker Engineering Laboratories at University College, Liverpool.

On the last day of the meeting a paper by Mr. Saniter on the "Elimination of Sulphur from Iron," and one by Mr. Stead on practically the same topic were read. The latter was a very long contribution, so long that it took nearly the whole time of the sitting to read, and its discussion was therefore postponed until the spring meeting of next year. The elimination of sulphur is an important question for the iron maker which has come forward rather prominently during the last year or two. It should be stated that when Mr. Stead had finished the reading of his paper proper, he stated that since the paper had been written he had made further experiments and gained additional information which corrected his former facts. He therefore produced a MS. which appeared to be as long as his original paper and read it through. Mr. Stead's work is always valuable, but it could be wished that he would get it into more orderly form before making it public.

* Sulphate of ammonia is now quoted in the New York market at 2½ to 3 cts. per lb. wholesale.

COMING TECHNICAL MEETINGS.

ENGINEERS' SOCIETY OF PHOENIXVILLE.
Nov. 1. Secy., W. Halliburton.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Nov. 2. Secy., F. Collingwood, 127 East 23d St., New York.

ENGINEERS' CLUB OF ST. LOUIS.
Nov. 2. Secy., Arthur Thacher, Odd Fellows' Building.

WESTERN SOCIETY OF ENGINEERS.
Nov. 2. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.

ENGINEERS' CLUB OF MINNEAPOLIS.
Nov. 3. Secy., F. W. Cappelen, 1628 H nnepin Ave.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Nov. 3. Secy., C. H. McLeod, Montreal, P. Q.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Nov. 4. Secy., E. K. Smoot, 806 Commerce St.

TECHNICAL SOCIETY OF THE PACIFIC COAST.
Nov. 4. Secy., O. Von Geldern, 719 Market St., San Francisco.

SWEDISH ENGINEERS' CLUB.
Nov. 5. Secy., P. Valentine, At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia.

NORTHWEST RAILROAD CLUB.
Nov. 5. Union Station, St. Paul.

MONTANA SOCIETY OF CIVIL ENGINEERS.
Nov. 5. Secy., F. D. Jones, Helena.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Nov. 7. Secy., C. L. Annan, City Engineer's Office.

NORTHWESTERN SOCIETY OF ENGINEERS.
Nov. 8. Secy., D. W. McMorris, Burke Block, Seattle, Wash.

CIVIL ENGINEERS' CLUB OF CLEVELAND.
Nov. 8. Secy., Chas. S. Howe, Case School.

DENVER SOCIETY OF ENGINEERS AND ARCHITECTS
Nov. 8. Secy., Geo. H. Angell, 36 Jacobson Block.

ATLANTA SOCIETY OF CIVIL ENGINEERS.
Nov. 8. Secy., Parker N. Black, Capitol Block.

CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Nov. 9. Wichita, Kan.

NEW ENGLAND RAILROAD CLUB.
Nov. 9. "High Speed for Trains." Secy., F. M. Curtis, O. C. R. R., Boston.

ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Nov. 10. Secy., Edward Mead, Norton Building.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Nov. 10. Secy., E. N. Clark, Pittsburg, Pa.

WESTERN RAILWAY CLUB.
Nov. 10. Rookery Building, Chicago. Secy., W. H. Marshall.

ENGINEERING ASSOCIATION OF THE SOUTH.
Nov. 10. Annual meeting. Secy., O. H. Landreth, Nashville, Tenn.

NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Nov. 11. Secy., D. W. Meeker, St. Paul.

WISCONSIN POLYTECHNIC SOCIETY.
Nov. 14. Secy., M. G. Schinke, City Hall.

ENGINEERS' CLUB OF KANSAS CITY.
Nov. 14. Secy., Waterman Stone, Baird Building.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Nov. 14 to 18. Annual meeting. Secy., F. R. Hutton, 12 West 31st St., New York.

ROADMASTERS' ASSOCIATION OF AMERICA.
Nov. 15, 16, 17. Chattanooga, Tenn., and Atlanta, Ga. Secy., J. H. K. Burgwin, Grand Rapids, Mich.

BOSTON SOCIETY OF CIVIL ENGINEERS.
Nov. 16. Secy., S. E. Tinkham, City Hall.

ENGINEERS' CLUB OF CINCINNATI.
Nov. 17. Secy., J. F. Wilson, 24 W. 4th St.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Nov. 17. At Atlanta, Ga. Secy., F. A. Charpiot, Macon.

SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Nov. 17. Secy., C. P. Franson, Fortune Block.

TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
Nov. 18. 201 Washington Building.

ENGINEERS' CLUB OF PHILADELPHIA.
Nov. 19. 1122 Girard St. Secy., L. F. Rondinella.

CENTRAL RAILWAY CLUB.
Nov. 23. Secy., S. W. Spear, E. Buffalo, N. Y., Iron Works.

NEW YORK RAILROAD CLUB.
Dec. 15. Secy., H. G. Prout, 73 Broadway, N. Y.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York. Entered at the Post Office, New York City, as Second Class Matter.

VOL. XXVIII. THURSDAY, OCTOBER 27, 1892.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

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The late fast run of the "City of Paris" has again caused a general confusion in the terms "knots" and "miles" in expressing the rate of speed. Two of the chief dailies of this city use the expression of "2,782 knots" and "2,782 miles" in the same article as meaning the same total run. If nautical mile is meant the term is all right; but it ought to be so stated; as a nautical mile is 6,080 ft. and an English statute mile, with which many readers confound it, is 5,280 ft. A nautical mile is the 1-60th of a degree, or one minute of arc, and hence varies with the latitude; according to some authorities. But the U. S. Coast and Geodetic Survey, about 1880, in order to remove all uncertainty and to introduce uniformity, adopted the following definition: The nautical mile is the one-sixtieth part of the length of a degree on the great circle of a sphere whose surface is equal to the surface of the earth. This value, computed on Clarke's spheroid, is 1,853.248 meters, or 6,080.27 ft. This value corresponds to the English Admiralty standard "knot" of 6,080 ft., and this is the length of the nautical mile or knot properly used in speaking of the speed of vessels.

The influence of local surroundings on inventive genius is a phenomenon which has often been noted. The patent office records do not show Louisiana inventors devoting their attention to snow plows or Maine Yankees studying the unsolved problem of automatic cotton picking. Under usual circumstances the work of an inventor will reflect to some extent the conditions with which he is surrounded. It is because of these facts that a recent invention of a resident of Kansas deserves some slight notice here. The invention is not, as might be supposed by one who knew Kansas in 1887, an automatic stake driver for the use of railway surveyors or even a new type of portable house. It is a weed-cutter for railway tracks, the invention of Mr. Wm. G. Hay, of Concordia. So far as we know the inventor has not been boycotted by his fellow-citizens, as it is safe to say would have been the case had he made and published his invention some five years ago, when the state was being gridironed with railways and a good part of its area was laid out in city lots. In those days every new railway was destined to be a trunk line, and the cities which were growing up like mushrooms on every hand promised to furnish such a traffic that weeds would never have a chance to show their heads between the rails. Rock ballast rather than weed cutters was the promised requirement of Kansas railways in 1887.

A comparison of our map of railway construction in the Southwest, published Oct. 10, 1892, with one of our early maps of this section (say No. 6, March 3, 1888), furnishes considerable food for reflection. The state which built over 2,100 miles of railway in 1887 has now 18 miles under survey and not a single other bit of new construction in any stage with sufficient foundation to warrant its showing upon our map. For years to come, until she grows sufficiently to support the railways with which she was too lavishly supplied in the boom of 1887, Kansas will probably be a sterile field for railway promoters.

Two engineers have recently been appointed on important state commissions by Gov. Russell, of Massachusetts. The first appointment, made a few weeks ago, was Mr. W. E. McClintock, M. Am. Soc. C. E., of Boston, to the new State Highway Commission. Last week Mr. Desmond FitzGerald, M. Am. Soc. C. E., of Boston, was appointed member of the State Topographical Survey Commission. The appointment of engineers on such commissions seems natural enough, but engineers know that such appointments are far too rare, or are made for political reasons instead of for high professional qualifications. Massachusetts, however, has long recognized the value of scientific training, as those familiar with work of its many commissions, past and present, know. To mention only two existing commissions, the Railway Commissioners now have as a member Prof. Geo. F. Swain, member of both the American Societies of Civil and Mechanical Engineers, and the State Board of Health has Mr. Hiram Mills, C. E., as a member; Mr. F. P. Stearns, M. Am. Soc. C. E., as Engineer, and Profs. W. T. Sedgwick and T. M. Drawn as Consulting Biologist and Chemist, respectively.

THE USE OF TRACTION ENGINES.

Traction engines, or road locomotives, belong to a class of engine which has occupied the attention of inventors and engineers since the earliest period of steam locomotion, and the idea of building engines to run on common roads, thus saving the enormous cost of roadway incidental to railway locomotion is certainly a very attractive one. For high speeds and passenger traffic, however, these engines have as yet only been applied to a limited extent, but they are widely and successfully used in England and elsewhere for slow heavy traffic, such as hauling threshing machines and freight wagons, and for plowing purposes. In this country traction engines are not extensively used, owing largely to the poor condition of the average country road, but with the general movement in favor of road improvement, the ever increasing demand for additional transportation facilities, and with the steady advance of improvement in engine construction, a wider field seems now to be opening up. It is also to be remembered that the engines have been successfully used abroad on bad roads. For hauling and driving threshing machines traction engines are used to a considerable extent in the wheat growing districts of this country, and are built by a number of builders of agricultural machinery. In this issue we publish an article dealing with this subject, and shall follow it with other articles on experience in this and other countries.

This present article is an interesting paper on the use of traction engines in England, written for us at our request by Mr. W. Fletcher, who has been connected with the design and construction of traction engines for some years, and is the author of the work on "Steam Locomotion on Common Roads," which was reviewed in our issue of Aug. 8, 1891. In a later article which we have compiled from various sources, we shall give many notes of experience under varying conditions. Steam road rollers are included in the consideration of the subject. It will be noted with some surprise that Mr. Fletcher refers to the bad condition of roads in England, but it must be borne in mind that the heavy traffic in the agricultural districts is largely over the side roads and small country roads, which are but little cared for and cannot compare with the excellent main roads generally available for traffic between country towns and between those towns and the railways, as noted later on in an extract from an English author's work. In view of the condition of the majority of American roads it would be specially interesting to have particulars of actual service or tests made as to the performance of traction engines in heavy mud.

In England the laws regulating the operation of traction engines are old and in many ways inapplicable to modern engines and conditions, but they are very stringent and harassing, and in some ways almost prohibitive. Steps are being taken, however, to secure the revision of these laws, as noted elsewhere. In this country new laws and regulations would be made as required by the growth of this system of transportation.

In "Field and Hedgerow," by the late Richard Jefferies, author and essayist, of England, is a most interesting essay on "Steam on Common Roads," in which he strongly advocates the general adoption of this class of traffic in the country districts as a feeder system to the main lines of railway. He points out the advantages to the farmers of having the road cars or wagons loading and unloading at the farms, and suggests car bodies that can be transferred, with certain classes of bulk freight, from the frames of the road cars to those of the railway cars. The advantages of road trains for passenger and freight traffic to villages and country places situated away from the railways is also referred to, and he states that while the railway is expensive and rigid, requiring its business to be brought to it, the road train is inexpensive and flexible, can go up hill and down dale to any desired point at regular or irregular intervals, and can be brought to the crops, the barnyard, etc. Why the system of trains briefly outlined in the following extract from the essay above mentioned is not brought into general practice is, he says, largely due to the Acts of Parliament regulating agricultural engines, which acts were passed at a time when steam was still imperfectly understood and road locomotives, in the modern sense of the word, were hardly thought of. The extract is as follows:

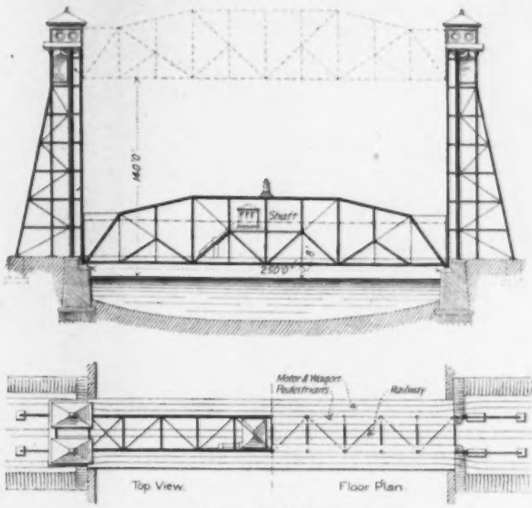
> As we have in this country no great natural waterways like the rivers and lakes of the United States, our best resource is evidently to be found in the development of the excellent common roads which traverse the country, and may be said practically to pass every man's door. Upon these a goods train may be run to every farm, and loaded at the gate of the field. The thing, indeed, is already done in a manner much more difficult to accomplish than that proposed. Traction engines, weighing many tons, and drawing trucks loaded with tons of coal, chalk, bricks and other materials, have already been seen on the roads, traveling considerable distances and in no wise impeded by steep gradients. What is this but a goods train, and a goods train of the clumsiest, most awkward, and consequently unprofitable, description. Yet it is run, and it would not be run were it not to some extent useful. It may be asserted without the slightest fear of contradiction that there are at least 50 engineering firms in this country who could send forth a road locomotive very nearly noiseless, very nearly smokeless, certainly sparkless, capable of running up and down hill on our smooth and capital roads, perfectly under control, not in the least alarming to horses, and able to draw two or more trucks or passenger cars round all their devious windings at a speed at least equal to that of a moderate trot, say eight miles an hour.

THE EXPANSION OF A 1,100-FT. RAIL.

The experiments on the expansion of continuous rails which are described on another page by Mr. A. J. Moxham are exceedingly interesting, for they were made in a new field and produced most surprising results. It has been known for some time that the Johnson Co. of Johnstown, Pa., had under investigation the electrical welding of rails. The experiments described by Mr. Moxham were undertaken by this company to ascertain the behavior of long lengths of continuous rail as respects contraction and expansion. They seem from the description to have been made with exceeding care and to be thoroughly reliable, even though the results obtained contradict accepted opinions.

Briefly it was found that the changes of temperature in a 78-lb. street rail of girder pattern embedded in a macadam road followed closely the changes of temperature of the air. This was to be expected, although there is a more or less general impression among street railway men that provision at the joints for expansion and contraction is not as necessary as with steam railway track, as was noted in the paper on "Recent Improvements in Electric Traction," published in our issue of Sept. 29.

The important fact developed by the experiments, however, was that this rail, 1,100 ft. in length, al-



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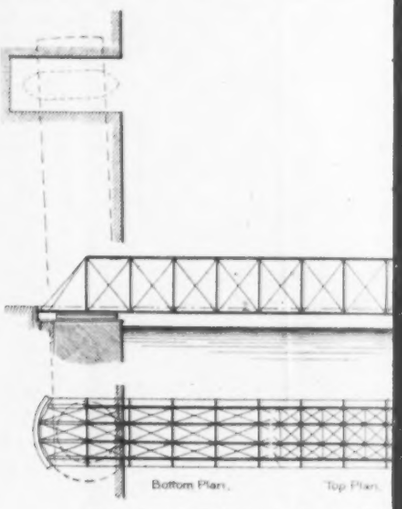

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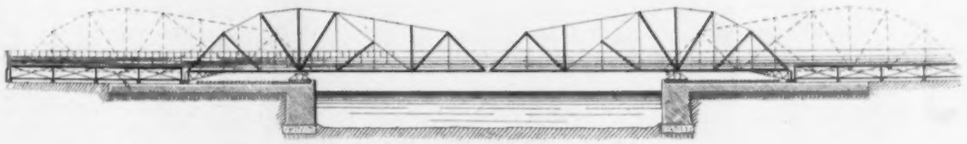

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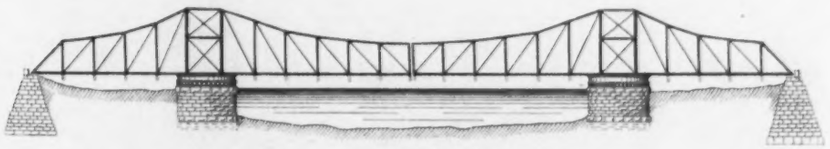

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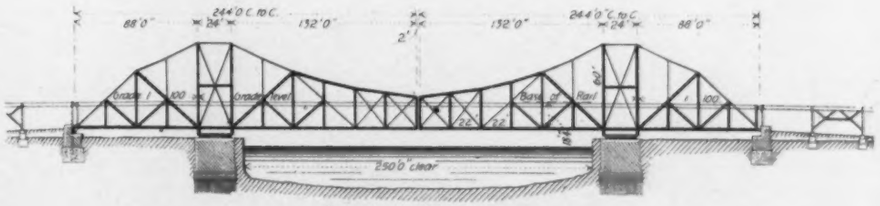

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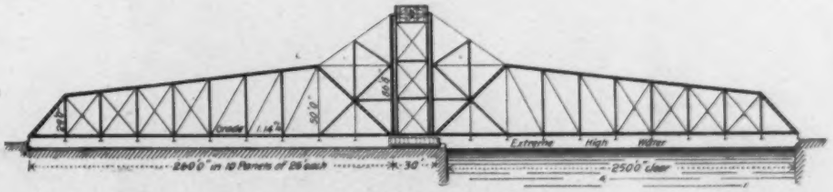

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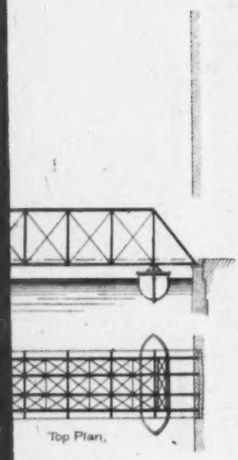

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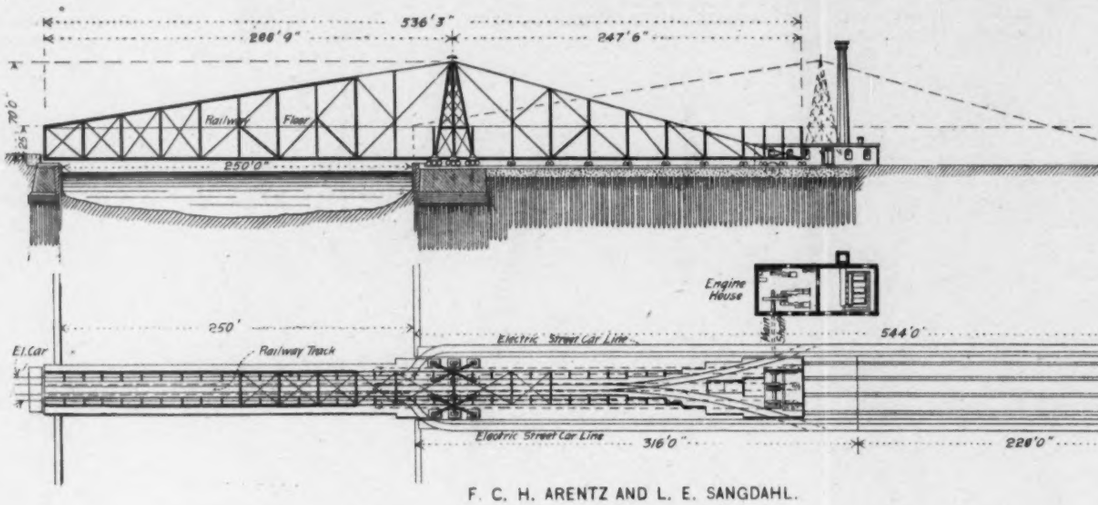

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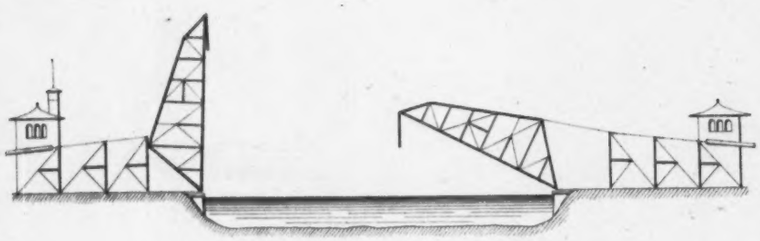

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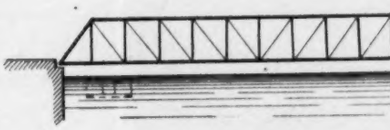

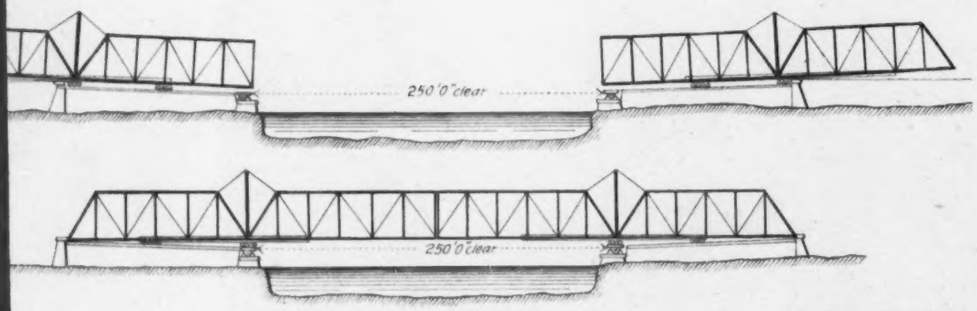

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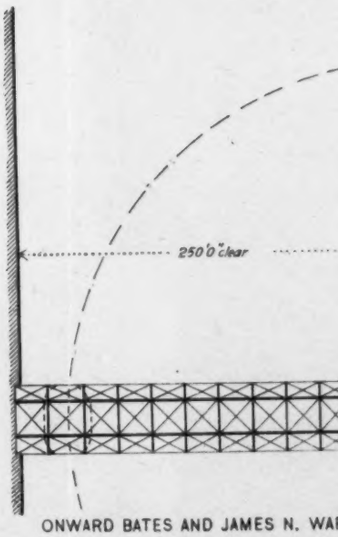

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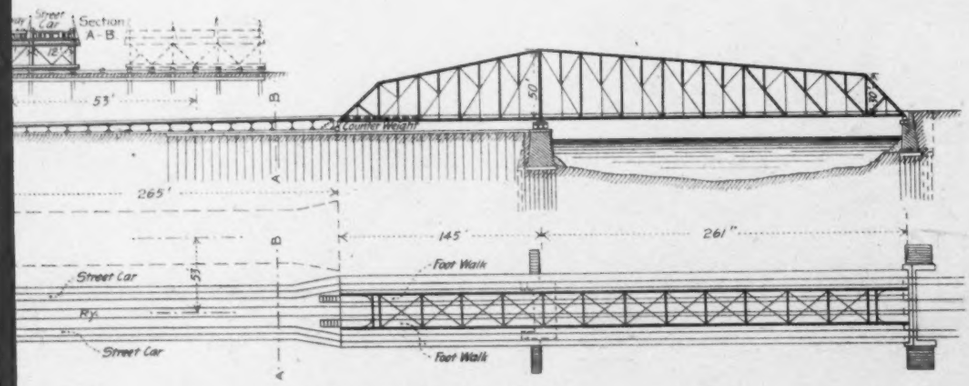

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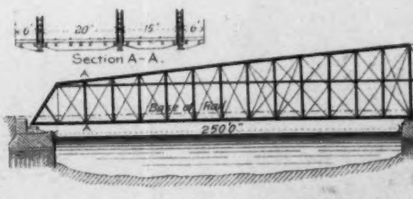
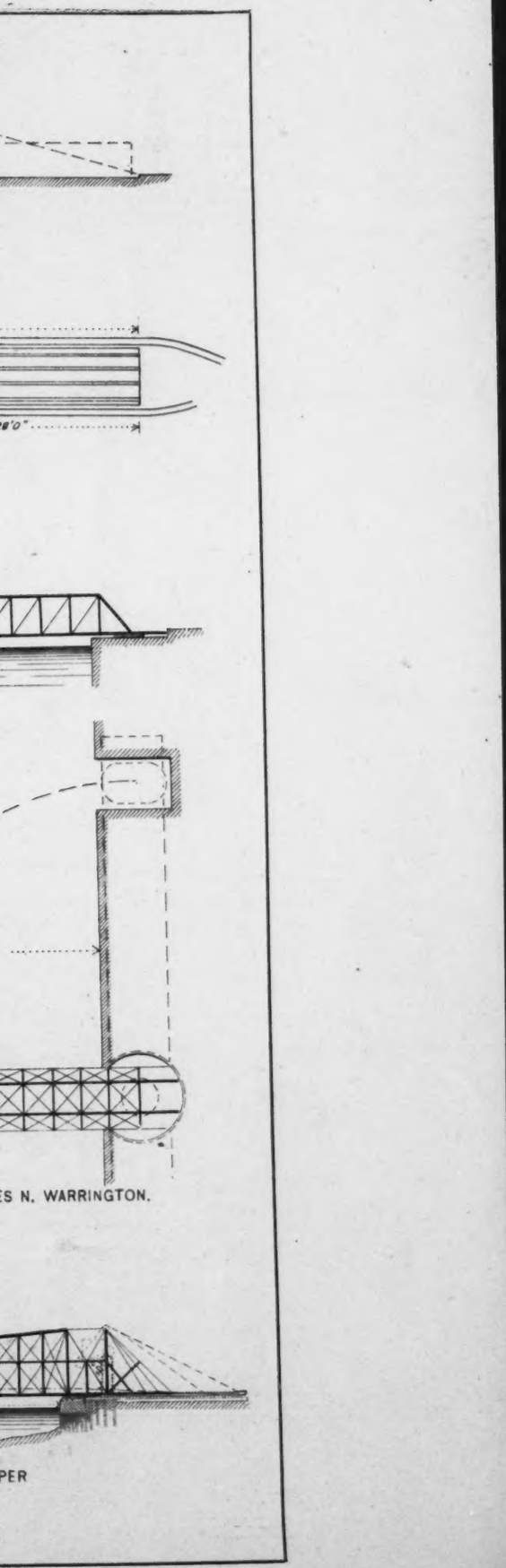


A. S. COOPER

NS FOR DRAWBRIDGE OVER SHIP CANAL AT DULUTH, MINN.



ES N. WARRINGTON.

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though exposed to temperatures varying from 10° to 121°, showed no measurable expansion or contraction, even at the ends. That this heating and cooling tended to lengthen and shorten the rail is beyond question, and this tendency could only have been overcome by the exertion of a considerable force tending to hold the rail in place. Mr. Moxham holds that the friction of the macadam roadbed against the sides of the rail was the resistance which prevented linear expansion and contraction; and indeed there was no other resistance to prevent it, if we except the small frictional hold of the spikes upon the rail.

The surprising thing is that the macadam should hold the rail with so tight a grip. A little investigation may be of interest. Taking the modulus of elasticity of steel at 29,000,000 and its coefficient of expansion at 1-150,000 per degree Fahrenheit, we have the compression or tension in pounds per square inch produced by a heating or cooling of one degree:

$$29{,}000{,}000 \div 150{,}000 = 193.$$

The temperature of the track when the shims were driven into the joints and the rigid splices were applied varied from 10° to 80°. If we take 40° as the average, we have a total variation of temperature of 80°. (The highest temperature of the rail during the summer was 121°). Then $193 \times 80 = 15{,}540$ lbs. per sq. in. The cross-section of the rail tested was about 7.6 sq. ins., hence the total compression of the rail when at the highest temperature was $15{,}440 \times 7.6 = 117{,}344$ lbs.

This is the compressive strain which will exist in a rail of this section of any length, short or long, which is heated 80° and absolutely prevented from linear expansion. The force which prevents this motion is the friction of the macadam roadway against the sides and bottom of the rail, and we may assume without much error that this is a constant amount per square inch of surface in contact. It follows from this that a certain length of rail is necessary to prevent expansion from taking place. For example, a section of the rail a yard long would expand and contract even if embedded in solid concrete, while a section five miles long might be prevented from expansion and contraction even by the slight friction due to embedding in soft, moist earth. The experiments of Mr. Moxham enable one to determine very closely what is the frictional resistance of macadam roadway packed against a rail. If we consider successive sections of the rail, beginning at one end, it is evident that the section at the end is under no strain, the next section is under a slight compression, the next under a greater and so on until we reach a point where the full compression due to the tendency to expand will be exerted. By a little thought it will be seen that the compression at any point from the end until we reach this point of full compression will equal the total frictional resistance toward the end from this point. Since with the uniform friction per square inch which we suppose, the total resistance increases uniformly as we go from the end, we have a section of rail, extending from the end up to this point, in which the average compression is one-half that due to the increased temperature and the average expansion of which, therefore, is one-half that due to the increased temperature. In other words, on this end section of the rail up to the point where the resistance is great enough to stop all motion, we have on the average half the extension due to the given heating in a free rail and half the compression due to the given heating in a rail prevented from motion.

Mr. Moxham states that "absolutely no movement of the track out of place occurred even at the ends," but his measurements seem to have been taken principally to discover lateral or vertical displacements. He does not state what was the limit of accuracy of his method of measurements; but for the sake of studying the question let us suppose that his measurements were correct within ⅛ in. as the rail was heated from the lowest to the highest temperature. The frictional resistance of the macadam may then be computed as follows:

This expansion is that due to 80° change of temperature in a length of 234 ins., hence double this distance or 468 ins. (39 ft.) is the length of macadam whose frictional resistance equals the total compression due to the 80° heating, or in this case 117,344 lbs. The total length of the base and sides of the rail against which the earth is packed is 21 ins., hence the total frictional area is $21 \times 468 = 9{,}828$ sq ins. Dividing 117,344 lbs. by this quantity we have a little less than 12 lbs. per sq. in. as the frictional resistance of the macadam. While this seems perhaps like a high resistance, it is to be remembered that a solid packed macadam roadbed over which teams are constantly passing must hold the rough surface of an iron rail with a pretty tight grip.

It will be noticed in the above discussion that we have made no reference to the lateral or vertical displacement of the rail under compression to which Mr. Moxham seems to have paid most attention, as was perhaps natural in view of the experiences on steam railways with track springing out of line by expanding rails. A little consideration shows, however, that in any moderately firm roadway, compression on a straight rail, due to the tendency to expand, could not cause displacement. The compression in the rail can only exert a lateral or vertical force of considerable amount when buckling is permitted to begin; as long as the earth and stone at the sides holds it firmly in line there is very small tendency to rise or spring sideways.

Mr. Moxham states in his paper that the roadbed will hold a rail 10 ft. or 30 ft. long from expansion as well as one of 1,100 ft.

But from the above demonstration it appears that under the assumed conditions there must be some movement at the end of the rail in any event, although it may be so small to be easily overlooked, and that not until a certain distance from the end of the rail is reached will motion entirely cease. If the above general demonstration does not make this clear to the reader it may be made plain, perhaps, by considering an especial case, as follows:

Suppose we consider a section of this rail at a point 1 ft. from the end. If the short piece of rail between this section and the end has nothing around it and no resistance preventing its motion and it is heated 80°, expansion will certainly occur. If it is so held as to be absolutely prevented from lineal expansion, a compressive strain will be set up in the metal, amounting, by the computation above, to nearly 120,000 lbs. Manifestly, if the resistance is less than this compressive force, motion will take place. But the resistance which acts to prevent motion is the friction of the macadam against the surface of the rail, and this of course varies with the surface exposed, so that a 2-ft. length of rail imbedded in the earth will be twice as hard to force lengthwise as a 1-ft. length. Therefore, until we reach a sufficient distance from the end to make the frictional resistance equal the compression due to the expansion, some motion must take place.

An advance proof of this discussion was sent to Mr. Moxham and we append his reply below.

The practical importance of these experiments will certainly not be underrated by engineers. It will probably be news to many members of the profession that many street railways are now being constructed with no space whatever at the rail ends for expansion and that no trouble results from track buckling or springing out of line. Our readers will also notice with interest the record of an experiment similar to that of Mr. Moxham's, which is being tried at Cleveland and is reported by Mr. Chas. W. Wason, in the discussion on "A Model Electric Railway Roadbed," published on another page. In this case the rail splices are secured by riveting instead of bolting, after the rail ends are drawn up snug. This track is about 1,000 ft. long, was put in service last March, and showed no signs of buckling during the hot weather. We append Mr. Moxham's letter as follows:

Sir: In response to your editorial upon "The Expansion of an 1,100 ft. Rail," I fear that the article it criticises, which was written hurriedly, is to blame for some misunderstanding on your part. The measurements taken were not only for lateral and vertical displacements, but also just as carefully for longitudinal displacements, at a series of points in the length of the rail. Though great care was taken in the measurements, no movement was found longitudinally in any part of the rail, even at the ends, although there was a space left at either end of the rail. I therefore think the indications point to the accuracy of my conclusion that the roadbed will hold the rail against expansion regardless (within practicable limits) of its length. Disregarding (if it is safe to do so) the effect of the material from the roadbed that would naturally work in to the vacant space between the ends of the 1,100-ft. rail, and the ends of the next adjoining rails, certainly there was nothing to prevent the two ends of the 1,100-ft. rail (say the last 10 ft.) moving, and it seems to me that so far as these two ends were concerned, it is immaterial whether they form part of an 1,100-ft. rail or part of a 30-ft. rail. If it takes a certain length of roadbed to counteract the tendency to longitudinal motion of the rail, there must exist that motion within the limits of this assumed length of roadbed and its absence in the experiment would seem to indicate that either the length of roadbed needed was but small, or, as I have concluded, that for all practical purposes the surface friction is continuously able to withstand the tendency to motion; which of the two for practical purposes seems to me immaterial.

The rail in question is to be carefully tested during the whole of the coming winter, and we may have something of interest to add to the present paper during the coming year.

I would further add that the tables of temperature given in the article are but averages and not details, and I will gladly put at the disposal of anybody wishing to study the matter more closely the detailed figures, which indicate many interesting possibilities and peculiarities. Yours truly,

A. J. Moxham.

Johnstown, Pa., Oct. 24, 1892.

GARBAGE DISPOSAL FOR NEW YORK CITY.

A report upon the final disposition of street sweepings, garbage, etc., gathered in New York city, has recently been made by a committee consisting of Mr. T. W. Myers, Comptroller, and Mr. E. P. Barker, President of the Department of Taxes and Assessments. The committee classifies the material deposited at the dumps as follows: Ashes, 62%; garbage, 12%; street sweepings, 24%, and ice and snow, 2%. In commenting on these component parts of the city refuse they say that the ashes, when clean, are valuable for filling sunken lots and low lands; dry street dirt is found to average only .369% of nitrogen and they think its composition offers no serious menace to health wherever deposited, and snow and ice can be dumped into the river from docks and slips. This would dispose of 88% of the matter collected by the Street Cleaning Department, provided that the garbage can be separated from the other material in collecting. While the committee believes this separation is practicable, and notes that this is done with more or less success in Boston, Brooklyn, Baltimore, Washington, Philadelphia and Buffalo, it does not recommend any particular system for adoption. Whatever method may be adopted can be put in force in New York without further legislation and as soon as the city authorities see fit to promulgate an order to that effect. Section 576 of the Consolidated Act, provided that "The Board of Health shall cause to be enforced the provisions of their sanitary code, requiring that separate receptacles be provided for ashes and rubbish and for garbage and liquid substances," etc.

Assuming that the separation of garbage can be effected in this manner, the committee summarizes the cost of the extra work of collecting as follows: It is estimated that the collection of refuse for 1893 will amount to 2,000,000 cart loads. Of this amount 240,000 loads will be garbage, and from experiments made by the Department in 1890, the average cost of collecting garbage separately is 28 cts. per cart load, or a nominal additional cost of $67,200 per annum. The city now enjoys an income of $93,000 paid by contractors for "trimming" the dump scows, and the material from which the contractor finds his profit is found entirely in what is designated as garbage. If this practice is continued there would still be a profit of $25,000 to the city. But the chief pecuniary advantage of this separation would be found in the clean ashes, which would instantly possess a commercial value as filling for low lands, docks, etc. belonging to private owners or to the city.

As to the final disposal of the garbage, the committee says it has had submitted to it several plans for cremation that promise success; but owing to the limited time at its disposal it does not see fit to commit the city authorities to any particular plan. The committee believes that no conclusion on this head should be reached without thorough scientific investigation, commensurate with its importance. But owing to the volume of this material gathered in a great city like New York, it is

probable that years will elapse before a thoroughly satisfactory system can be evolved, and in the meantime something must be done at once. The committee believes that to deposit this garbage in salt-water, in filling in low lands in the vicinity of New York, will be safe and economical, and will answer the end in view until a permanent system of garbage cremation may be finally decided upon.

The committee notes the fact that private owners have derived great profits from utilizing the material gathered by the Street Cleaning Department, and cites the land reclaimed at the Communipaw ferries of the New Jersey Central Railroad, the part of the city bounded by 92d and 106th Sts. and Third Ave. and East River; the sunken lands on the Harlem River, etc. As a place of immediate deposit the committee recommends Riker's Island, bought by the city in 1884. This island contains 87½ acres and by Act of Legislature of 1885, the city is empowered to reclaim and own all surrounding land under water within the 12 ft. contour, or 394 acres more. To fill the low land of the island to a level of 3 ft. above high-water would require 104,540 cu. yds.; to fill the shoal ground west of the island within the 12 ft. contour, would demand 1,818,000 cu. yds., and to fill the land east of the island, 8,635,600 cu. yds. more. This is a total filling required of 10,558,140 cu. yds. The average distance of towage involved is less than one-half that now in force and the island is accessible on each tide. The committee estimates that the saving effected by adopting Riker's Island as a point of deposit would amount to nearly $180,000 per year, or $613,711 during the time necessary to fill up the low land. At $3,000 per acre, the 394 acres of reclaimed land would be worth $1,182,000, less $694,188 for rip-rap, etc., required. Taking into consideration the saving in disposal for the whole term of years required and the land regained, the committee figures a total benefit of $1,101,523 from utilizing Riker's Island for this purpose. The chief advantage advanced is that the garbage need not be separated from the ashes, as the result of careful investigation is that absolutely no nuisance would result from depositing the garbage in salt-water at this point, says the committee. After the filling reaches the water surface the Health Department declares it can thoroughly disinfect it in such manner as to be entirely harmless and inoffensive. The committee concludes by recommending that the Dock Department be instructed to prepare plans and estimates for the cribwork or rip-rap required, and further public hearings be given for the purpose of considering the scientific final disposal of garbage, by cremation, desiccation or otherwise, with a view of the ultimate adoption of a satisfactory system for New York city.

LETTERS TO THE EDITOR.

RAILWAY CO-OPERATION IN THE GOOD ROADS MOVEMENT.

Sir: Permit me to call your attention to the inclosed copy of a letter which I have sent to a number of railway presidents, urging that each company establish a Road Department for the purpose of aiding in promoting the improvement of the common roads of the country. The subject is one of great importance, and I hope that you will advocate it in the columns of your journal. It may be urged that railways would find it advantageous to make special concessions in rates on all road material and road machinery delivered to points on their lines. Perhaps it would ultimately prove profitable to railways if they were to deliver without charge material and machinery to be used on highways directly connected with their stations. Very truly yours,

Albert A. Pope.

Boston, Mass., Sept. 28, 1892.

(We publish the letter with pleasure to do what we may to aid Mr. Pope and his allies in the grand work to which they have devoted so much and such intelligent and effective work, with which we need not say we are heartily in sympathy. As President Van Horne, of the Canadian Pacific Railway, has recently remarked, we "feel sure that the sum of all the other waste and extravagance in North America does not equal the waste and extravagance of bad roads." The particular suggestions made in this letter, moreover, seem to us well conceived and well put. The railways have an immense and direct interest in good country roads, and at nominal cost can do a good deal to hasten the day of their improvement.—Ed.)

(Letter to Railway Officials.)

Dear Sir: Permit me to urge upon your attention the great importance of good roads as feeders to railways. Throughout the United States the condition of the common roads is the index to the prosperity of railways. When highways are impassable, freight and passenger earnings are necessarily diminished and the price of railway securities lowered; when the roads are not in good condition, merchandise is accumulated at the depots, and in moving it trains are delayed and accidents increased. A uniform good condition of roads would enable railways to handle freights more expeditiously and advantageously.

Good roads are the means by which a country is built up populously and prosperously; bad roads delay civilization, and cause districts to be sparsely settled, and poverty and ignorance to abound.

The railway companies of this country, representing millions of employees and billions of capital, and controlled and directed by men of high intelligence, have a commanding influence in every legislative hall in the United States.

Every railway corporation can request its officers, agents and employees to do what they can to create a right sentiment in regard to the improvement of highways in their respective neighborhoods; and all along the various lines, depot masters and freight agents could report to a Road Department, established by the company, the condition of the roads in their towns and what is being done to improve them. These depot masters could be furnished from time to time with pamphlets containing instructions for the construction and maintenance of highways, for distribution to persons doing business at their stations, and thus educate them how to build better roads, as well as teach them that better highways effect saving in transportation. Any railway running through a territory having good roads must have a great advantage over a competing line with poor roads from its stations.

The executive officers of a railway corporation can instruct representatives in Congress on the importance of better highways so that favorable legislation may be secured; newspapers to whom railway companies extend their patronage might be requested to devote space to agitating this matter.

The building up of suburban districts, which is of such a profitable character to railways, is first brought about by the construction of good roads by those who wish to sell land.

Aside from the material advantages that may accrue to a railway by its aiding in the work of agitating this subject, there is to be considered the broader question of the great benefits that might be conferred upon the entire community. Will you not aid this great movement which is of so much national importance?

Very truly yours, Albert A. Pope.

Boston, Mass., Sept. 26, 1892.

THE CONGRESSES AT THE WORLD'S FAIR.

Sir: In reply to article in Engineering News, of Oct. 6, I beg leave to say that great care has been taken in the organization for the World's Congresses, of 1893, to guard against the difficulties suggested in your article. The regulations are such that there will be no unseemly conflict, nor any haphazard discussion in any of these congresses. The preliminary publications are merely intended to call attention to the general field to be occupied by the congress, and to elicit suggestions to be utilized in forming the program. I think you will find, in the notes to the inclosed list of congresses, and the dates when they will be held, an answer to most of the objections suggested in your article.

Very respectfully yours,

Clarence E. Young,

Assistant Secretary to the World's Congress Auxiliary of the World's Columbian Exposition.

Chicago, Oct. 12, 1892.

Our criticism was based partially on the "preliminary address" published by the committee on the "Railway Commerce Congress," containing a preliminary program with subjects enough and work enough to occupy weeks. As nearly as we can estimate by the list of congresses above referred to, this represents something like 1-200 of the total work be done in the various congresses. The projectors of the World's Congress Auxiliary have divided the whole field of human activities into 10 "Departments." Each department is subdivided into "General Divisions," and some of the General Divisions seem to have scope for several congresses or conferences. For instance, Insurance is a General Division under the Department of Commerce and Finance; and there are half a dozen different Insurance Congresses enumerated.

We quote from the official publication the measures adopted to steer clear of some of the dangers referred to in our editorial note:

The themes to be presented in the various Congresses will be selected with a view to make a complete and orderly treatment of the general subject embraced in the Department; the programs of the different departments and divisions will be carefully compared; and all papers and remarks will be strictly limited to an allotted time. It will obviously be better, in a given hour, to have two or three compact papers from as many different leaders, than to give the time at command to one of them for a long discourse, embracing several subjects. The object will be to state results and present existing problems, and for this purpose lengthy papers are neither necessary nor desirable.

Unprepared discussion or miscellaneous debate would obviously be inconsistent with a plan of which the chief object is to procure the maturest thought of the world on all the great questions of the age, in a form best adapted to universal publication. The time at disposal after the delivery of a discourse will therefore be given to the most eminent persons present, who will speak on the call of the presiding officer, and to whom such previous notice as may be practicable will be given. The summaries of progress to be presented, and the problems of the age to be stated in the World's Congresses of 1893, will not be submitted to the vote of those who may happen to be present, but will be offered for subsequent deliberate examination by the enlightened minds of all countries; for unrestricted discussion in the forum, the pulpit, and the public press; and finally for the impartial judgment of that exalted public opinion which expresses the consensus of such minds. With this end in view, remarks of leaders, in elucidation of a subject, will take the place of ordinary debate.

The executive administration of each Congress will necessarily be in charge of the Committee of Arrangements and the officers of the Auxiliary, who alone can be familiar with all the details involved. But the plans of the Auxiliary have always provided that the largest practicable number of persons eminent in the work involved in a given Congress, shall be asked to act as presiding officers during different sessions of the Congress, or even during different parts of the same session, thus justly honoring distinguished participants, and gratifying the members of the Congress with an opportunity to see and hear, not only those who will read discourses on the occasion, but also others with whose names and works they may be more or less familiar.

The program further states that an official invitation has been extended to all the Governments of the world to send delegates to the congresses and that a further invitation is extended to institutions and societies of other countries to appoint delegates. "Individuals eminent in any department of human progress are also particularly and cordially invited to attend the congresses in which they are respectively interested." Any of our readers who wish further information can probably obtain a copy of the official program by addressing the World's Congress Headquarters at Chicago.

It is evident that the World's Congress Auxiliary has undertaken a very large contract, and it remains to be seen with what success it will carry it out. Certainly the attempt to secure a systematic presentation by the greatest men of the age of the advancement of the race in all departments of art and knowledge and of the problems which still press for solution is a most laudable one. We are glad to learn that the extensive pruning which was evidently necessary to bring the plans of the Congress on Railway Commerce into presentable shape will be undertaken.

The chief difficulty to which we allude, however, cannot be overcome. The official program is headed "Not Things but Men." We would respectfully suggest that "Not Things but Ideas" would better present the aim of the World's Congress Auxiliary. But the ideas which will be presented in words in the congresses will, many of them, be embodied in concrete form in the Exposition. When "things" appeal so strongly for the attention of intelligent visitors to the World's Fair, it seems doubtful whether many will care to spend time in listening to the reading of papers even by the most eminent authorities.—Ed.)

UNIFORM PRACTICE IN PILE DRIVING.

In our issue of Dec. 29, 1888, we published an article under the head of "Formulas for Safe Loads of Bearing Piles," in which we analyzed at some length the various existing formulas for pile driving and proposed the following formula for general use, as simpler and more trustworthy than any of them:

$$L = \frac{2\,wh}{s+1}$$

in which L = the SAFE load on the pile in any unit of weight, w = the weight of hammer on the same unit, h = the fall of hammer in feet, and s = the set of pile under the last blow in inches, determined in practice by computing the mean set under several of the last blows.

This formula has since become somewhat widely known and used as the "Engineering News" formula, and it has lately been made the subject of a new investigation by Mr. Foster Crowell, in a paper before the American Society of Civil Engineers* of which an abstract follows, in which he indorses the formula as on the whole the most

convenient and reliable of all, but proposes a modification of it under which the constant 1 of the denominator is divided into three different terms, only one of them a constant. An exceptionally full and valuable discussion followed, which we shall also abstract with some fullness in our next issue, though the demand which it makes upon our space is too great for it to appear with the paper itself. With the discussion we shall also give our view of the net conclusions to be drawn from all the facts presented.

After a short preamble stating the need for more general adherence to some recognized standards for pile driving, Mr. Crowell continues:

At the outset it may be well to bear in mind that in order to discuss the subject intelligently, we must keep separate the extreme sustaining power of any pile under a static load, and the character of the particular use or stress to which the pile is to be subjected. We will first consider a series of differing values, obtained by several different recognized formulas, for the sustaining power of the same pile under exactly the same conditions; we will then examine those formulas in detail and endeavor to select the most satisfactory one as a general formula for practical use; and, finally, we will study the consistent application of the formula so selected, to the varying conditions met with in actual practice.

Rudolph Hering, M. Am. Soc. C. E., in a very valuable monograph on Bearing Piles,* which cannot be too highly recommended as a most useful work of reference, has collated and tabulated no fewer than 14 different formulas attributed to 10 different authorities, which give 14 different values for the extreme sustaining power of the same pile, driven under precisely similar conditions; the values range in a typical case, all the way from 96,000 to 600,000 lbs., without taking into consideration the further differentiation resulting from varying views as to suitable coefficients of safety, which run anywhere from ½ to 1-100, so that if we were considering the working load for a given pile under extreme conditions, we should find it by one authority to be 4,500 lbs.; by another, 16,000; by a third, 48,000; by a fourth, 75,000; by a fifth, 120,000, and so on. It is to be remarked that one of the most eminent of the authorities gives five different formulas of varying

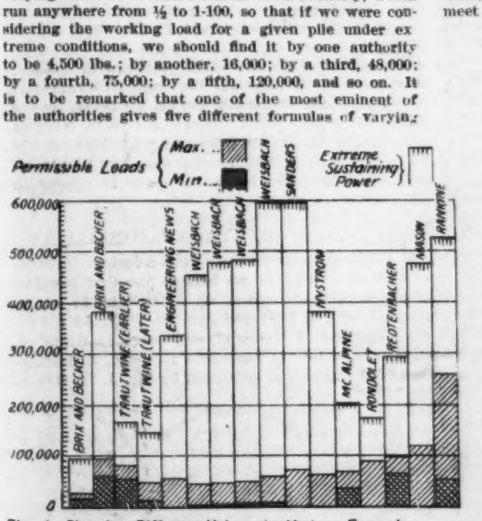


Fig. 1, Showing Differing Values by Various Formulas, in the Case of a 2000-Lb. Ram Falling 30 Ft. with Set of .1 Ft. (= 1.2 Ins.), of Extreme Sustaining Power and Permissible Loads.

theoretical exactitude, two others each give two forms to be used in separate cases, which in practice is quite difficult, even for an expert, to choose between; while none of the authorities attempt, except in the most general way, to make any classification of applications, but leave that entirely to the individual judgment, within very wide margins. This is most perplexing to those whose need of a working formula is most urgent and, in connection with the difficulty of making a correct prognosis, naturally tends to produce the great disparities in practice which we have noted, and which it should be our aim to avoid in order to attain to absolute economic security. The list of formulas best known, and which represents practically all the valuable literature on the subject, is as follows:

Weisbach.....in five forms.
Sanders.....one form of Weisbach.
Mason.....one form of Weisbach.
Trautwine.....in two forms.
Rankine.
Rondolet.
Redtenbacher.
Brix and Becker.....in two forms.
Nystrom.
McAlpine.
Engineering News.

* Trans. Am. Soc. C. E., August, 1892.

* "Bearing Piles," by Rudolph Hering, M. Am. Soc. C. E. Engineering News Publishing Co. New York, 1887

Fig. 1 exhibits the deduced values of extreme sustaining power, and the ordinary and the minimum loads, recommended by each authority in the case of a typical pile driven under ordinary conditions. The purpose of this diagram is merely to show variations in results.

It is evident from inspection of Fig. 1, that the authorities, as has already been stated, differ, not only as to safe loads, wherein there is reasonably room for such divergence, but also to a very marked extent in the theoretical extreme sustaining power. The "factor of safety," too, seems to be entitled to the nickname once bestowed upon its cousin of the iron bridge. But if we look a little closer at the forms of the formulas we shall see why such variations occur, and may perceive that if we had taken some other case, with a different weight of hammer and different fall, we should have obtained another, but quite different, set of variations, and so for every assumed case.

For our present purpose it will not be necessary to review the entire list of formulas, a few being sufficient for illustration. All the formulas are based, of course, upon the mechanical principle of accumulation of work.

If regarded as a mere question of dynamics, and if we could eliminate the elasticity and comprehensibility of hammer, pile and soil; neglect the consideration of their relative weights, and the frictional and other resistances to the motion of the hammer; then the theoretical resistance, or sustaining power of the pile would be found in the simple expression:

$$\text{Sustaining power} = \frac{\text{Weight of ram} \times \text{fall}}{\text{Space through which the hammer moves after reaching the pile.}}$$

But we cannot, as a matter of course, treat the matter thus simply, for it is in reality a very complex case of impact, wherein the exact application of principles to any particular case is well-nigh impossible under ordinary working conditions where the falling ram is used; but which the various authorities have sought to meet either with varying degrees of theoretical minutiae, by means of working factors, sufficiently comprehensive to cover all cases. Some of the formulas take into consideration the compressibility and weight of pile; others neglect one or both. It is easy, therefore, to see that they must differ. None regard the compressibility of the soil as a necessary element in the calculation, nor introduce specific factors of mechanical friction and air resistances as applied to the falling ram. The proper weight ratio of pile and hammer to secure the best results has received theoretical consideration, but as it would be extremely inconvenient and, in fact, impracticable, to select piles of definite weight, it is rightly regarded as a matter to be considered generally. The ram should always be at least as heavy as the pile; generally, in practice, it is from 25 to 200% heavier than piles which may be used in the same work.

It is evident, further, that, however interesting and involved the theoretical study of this question may be, a working formula should contain only those essential factors which can be readily obtained with reasonable correctness in the case of any pile, and it is not worth while nor sensible to waste time in refining a result beyond the refinement of the data. The frictional and air resistances can, however, be experimentally rated by chronographic methods once for all in the case of any particular machine, if that refinement be desirable, and expressed as a decrement for the actual fall. The Trautwine formula, which is probably used more extensively than any other in this country, takes no account of compressibility, weight of pile, or directly of frictional resistance to fall of ram, but considers the work done by the ram to vary as the cube root of the fall. While there is justification for this assumption in dealing with average falls, based upon increased air resistance and greater impact losses, yet the allowance would appear to be too great, giving too low values for the higher falls, and excessive results for very low ones.

In most situations it is necessary to treat piles individually in order that all in any group may be given the same measure of stability under varying conditions observed in driving, so that it is essential to apply the formula to every pile. On this account the form of a working formula is a matter of great importance, and to insure rapid and correct results it must be a simple expression involving only such data as can be quickly and correctly obtained for each pile, and requiring the minimum of computation for instantaneous application.

The only data that can be readily obtained are the weight (w) and the fall (h) of ram, and the penetration (s). The weight of the pile and its compressibility cannot be conveniently determined, and are so modified often by considerations of specific gravity and resilience that they would be of no practical account. In addition to that any "brooming" of the pile-head acts as a cushion, to an extent which completely discounts the theoretical natural compressibility. The consideration of brooming, like other mechanical questions which present themselves in connection with the art of pile-driving, does not properly come within the scope of this paper. A very instructive and precise record of the enormous cushioning effects due to this cause, as observed in a number of piles driven by a Nasmyth steam hammer, is contained in a very valuable paper on steam pile-driving, by D. J. Whittemore, Past President Am. Soc. C. E.*

If the proposition be accepted that we may profitably discard all working formulas, excepting those that involve only correct and accessible data, we may select from the foregoing list for further comparison the three following typical forms, rejecting the others as being either unnecessarily refined and unsuitable, or inconveniently cumbrous. In all three the notation is as follows:

w = weight of ram in pounds. h = height of fall in feet. s = penetration under last blow, in inches. F = working factor. L = load in pounds.

1. Weisbach (i. e. the form of Weisbach, wherein compressibility and weight of pile and elasticity of ram are neglected; this is usually known in America as Sanders').

$$L = F\frac{wh \times 12}{s}, \quad F = \tfrac{1}{6} \text{ to } \tfrac{1}{8}.$$

2. Trautwine (i. e. the form of Trautwine, wherein the pile is assumed to "sink appreciably, say, a few inches," under the last blow. In the later editions of this authority, the other form, for smaller penetrations, has been dropped and this is made general. See "Trautwine's Engineer's Pocket Book." 1889).

$$L = F\frac{\sqrt[3]{h} \times 50\ w}{s+1}, \quad F = \tfrac{1}{4} \text{ to } \tfrac{1}{10}.$$

3. Engineering News. (This name has been given to

* The Nasmyth Pile-Driver. Trans. Am. Soc. C. E., Vol. XII., page 441. 1880.

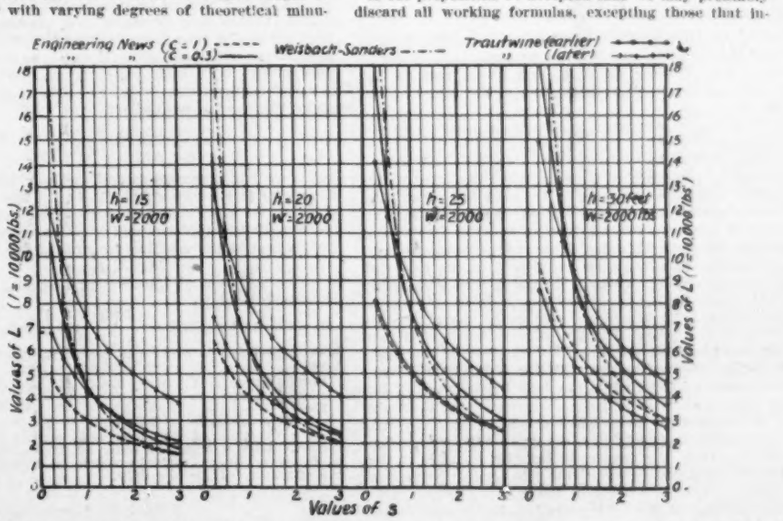

Engineering News (ε = 1)
" " (ε = 0.1)
Weisbach-Sanders
Trautwine (earlier)
" (later)
h = 15 W = 2000
h = 20 W = 2000
h = 25 W = 2000
h = 30 feet W = 2000 lbs
Values of L (= 10000 lbs.)
Values of L (= 10,000 lbs.)
Values of s

FIG. 2. SHOWING DIFFERING VALUES BY VARIOUS FORMULAS IN FOUR CASES WITH VARYING FALL AND VARYING PENETRATION UNDER CONSTANT WEIGHT OF RAM.

this form to distinguish it, the name of its originator not being known to the author; it first appeared in Engineering News of Dec. 29, 1889).

$$\text{Safe load} = \frac{2\,wh}{s+1}.$$

It will be noted that Nos. 1 and 3 are alike in the respect that each gives similar results for equal ram-energies, expressed in foot-pounds, irrespective of the fall, whereas No. 2 introduces a theoretically illogical variation in this product, which, together with the practical inconvenience of using the cube root in rapid application, without any gain in accuracy, would give preference, as far as form alone goes, to either No. 1 or No. 3 as a working formula.

In order to compare readily the results obtained under a variety of conditions, Fig. 2 has been prepared, exhibiting the respective values of safe static loads as given by the three formulas, in four cases of varying height of fall, with penetrations ranging from ¼ in. to 3 ins. under constant weight of ram. Were it not for the presence of the cube root in the Trautwine formula, one case instead of four would have been sufficient for comparing the three formulas. It is interesting to trace the effect of this factor through the successive plottings and to note that it is by no means inconsiderable, even within the comparatively limited range of fall.

The distinctive curves are plotted to abscissas of penetration in inches (value of s) and ordinates of working loads (values of L). As the Trautwine formula in its earlier form contained a somewhat higher coefficient and a maximum factor of ½ instead of ⅙, two Trautwine curves are necessary to make the comparison comprehensive, the more modern form giving the lower values. In order to show graphically the effect of the constant "c" in the Engineering News formula and to prepare for reference further on to a suggested modification of this formula, the curve, shown by the full line of the equation

$$L = \frac{w \times 2\,h}{s + (c = 0.3)}$$

has been introduced. In the Weisbach-Sanders formula F is taken at ⅙, and in all four cases w is taken at 2,000 lbs., h being 15, 20, 25 and 30 ft., respectively. Values of L are given in pounds, to the nearest thousand.

It is hardly necessary to mention that these curves are merely graphic representations having no generic value. But their comparison is instructive and we are struck by two practical considerations: first, that where the values of s are from ½ in. to 1 in., there is a closer approach to uniformity in the formulas than when s is either greater or less; second, the Engineering News' functions with constant (c = 1) gives values more and more conservative, comparatively, as the values of s become smaller, whereas the curve with c taken at 0.3, while growing conservative as s becomes greater, maintains more nearly an average of the other two where s is smaller. The first observation implies that the experiments preceding the adoption of all three formulas were conducted within a comparatively narrow range of falls; while the second points to the use of the lower value of c as being more logical, for it will be admitted that, other things being the same, the smaller the penetration, the greater the expectation of stability of the support to the pile, as well as the initial sustaining power of the pile itself. Proceeding a step further we find that the c curves converge in the direction of greater penetration, but preserve their conservative quality; whereas, in the opposite direction the Sanders curve gradually passes entirely out of the field of practicability. The conclusion seems to be warranted, therefore, that with a suitable value for c, the Engineering News' formula is more reliable and rather more convenient in practical use than Trautwine's, and equally as convenient and more conservative than the Weisbach-Sanders. It is to be borne in mind that within the range of moderate penetration (2 ins. or less) ample experience has demonstrated that for ordinary conditions any one of the three gives safe results.

In the discussion of the third division of our subject, the consistent application of the formula to varying conditions, the value of c will be considered.

We have seen that the form of formula No. 3, $L = \frac{2\,wh}{s+c}$ is the simplest, and that its results are reliable and conservative. If, then, it is found to be applicable to all cases without change of form, and, in addition, to be readily adaptable to classification, it will be suitable as a basis of uniform practice and also as a means hereafter of increasing our practical knowledge of the efficiency of bearing piles, by accumulating comparable results. The writer offers, as the only feature in this paper for which originality is claimed, a development of the formula which lends itself in a very elastic and consistent manner to the desirable end. It consists simply in making c a tangible variable for natural conditions, and a selective variable within limits according to the requirements of the case. In order to make this perfectly clear we should consider that there are three general cases in which modification may be necessary:

1. Where the load is static and known, but the natural support for the piles is insecure or doubtful.
2. Where the support is reliable, but the load is dynamic.
3. Where the support is not reliable and the load is dynamic.

In the first case, the variation can generally, though not always, be gaged by the resistance of the material into which the pile is driven, under what may be termed a standard blow. The writer considers that a 2,000-lb. ram falling 20 ft., or an equivalent product of 40,000 ft. lbs. on a 12-in. pile, constitutes a convenient standard for this purpose, and when the standard blow, or a series of such blows, is delivered on any pile, the observed penetration should in a majority of cases afford a tangible measure of the security of the stratum. If, then, we substitute for the constant value of c a series of values based on the above considerations, we can readily determine with practical correctness how to deal with pile-beds of various degrees of firmness.

The rule adopted by the author is to make c (for static loads) = .1 + n wherein .1 is an arbitrary constant, introduced to prevent exaggerated values of L with very small values of s, and n is made equal in the case of each pile to half the square root of the maximum penetration of the pile under a blow of 40,000 ft.-lbs, or more.

Table 1 gives corresponding values of n for different penetrations, and shows that within the extremes of penetration of about 1-6 in. to 3 ins. under the standard blow the values of c vary from .3 to 1, these being the values for the two curves of this formula in Fig. 2, which we have considered.

In the second case the selective variable should be used, and here the enginer must be guided by his experience or the experience of others as to the value of n′ to be selected; this will be further considered.

In the third case both the tangible and selective variables of n and n′ must be introduced.

The extreme case in which this formula should be used under the most favorable circumstances, is for a penetration of ⅛ in., as it is difficult to measure smaller penetrations with sufficient accuracy. The maximum value of L, therefore, (using c = .275, as given in the table), for s = 0 + would be

$$L = \frac{2\,wh}{.275} = 7.3\,wh,$$

which as h is expressed in feet and s in inches, gives a working factor still of 12 ÷ 73 = 1.7. But we should attach little value to small sets, which must always be viewed with suspicion, and often, moreover, indicate results beyond the crushing strength of the pile.

TABLE 1.

A General Pile-Driving Formula.

For Static Loads:

L = the working load $= \frac{2\,wh}{s+.1+n}$; w is weight of ram; h is virtual fall in feet; s is set in inches under last blow.

For Dynamic or Vibratory Loads:

$$L = \frac{2\,wh}{s+.1+n+n'}.$$

n is a function of the observed penetration, s′, in inches, under a standard blow of 40,000 foot pounds n′ is an arbitrary variable which is dependent upon the character of the pile duty.

Values of s′.		Values of n, $n = \frac{1}{2}\sqrt{s'}$	Values of n′ according to duty. classification	Classification.
⅛	inches.	.175	.1	Large buildings to contain light machinery in motion.
¼	"	.250	.2	Long span bridge abutments for railways.
⅓	"	.354	.3	Long span bridge abutments for highways.
¾	"	.433	.4	Buildings to contain heavy machinery in motion.
1	"	.500	.45	Short span bridge abutments for trestles for railways.
1¼	"	.559	.5	Short span bridge abutments for highways.
1½	"	.613	.55	Buildings subject to extraneous vibration.
1¾	"	.662	.6	Foundations for machinery.
2	"	.707	.7	Elevator towers in ordinary cases.
2¼	"	.750	.75	Bridge piers exposed to current vibration.
2½	"	.791	.8	Light houses exposed to ordinary wave action.
2¾	"	.830	.9	Foundations for turn-tables.
3	"	.866	.95	" pivot bridges.
3¼	"	.900	1.	Chimney stacks exposed to winds.
3½	"	.936		
3¾	"	.965		
4	"	1.		

This table applies solely to bearing piles; the results are to be taken only when found not to exceed safety as against fibre-crushing, or as against buckling in cases wherein the pile acts, wholly or in part, as a column.

In this consideration the author has purposely confined himself to piles proper and has not extended it to pillars or columns, which they sometimes become when driven through a soft stratum to an unyielding bottom, or into a denser lower stratum. In all such cases great care and discrimination is necessary as to what extent results given by the pile formulas can be used, and also as to the limitation of driving. These formulas are only for determining the efficiency of piles to distribute, throughout the stratum, loads which its surface cannot sustain. It is quite possible to overload the stratum by driving piles too thickly; it is sometimes thought that if three piles, for instance, are good in a certain area, six will "make assurance doubly sure;" this policy is not only costly and foolish, but in many cases it is dangerous. A certain public building in New Orleans, of which the author has heard, stands on an enormous number of square piles driven so as to touch one another; in other words, there is a solid wall of wood, and instead of each pile having four surfaces in contact with the sustaining stratum, only the outer rows have contact, and they but on two surfaces; there are, therefore, from four to six times too many piles used and the support is still much less than could have been obtained.

There seems to be objection in many quarters to piles for foundations of buildings, which is not warranted in the light of their record in engineering structures, and which greater care and closer economy in their use should dispel. As a rule, in the author's judgment, their sustaining powers are greatly underrated, and too much importance is attached to small "sets." He has before him the specifications for a large structure to rest on piles, which require that "all piles shall be driven to a half-inch set from a 2,500-lb. hammer falling 25 ft.," and the plans are drawn with the idea that that degree of firmness in each pile can and will be secured. Possibly experimental driving has already determined that the expected conditions will be found, but it is more than likely that in driving the piles, either considerable latitude will be taken or an excess of length will be used. Sometimes in the search for firm bottom, successive tiers of piles have been driven, one presumably on top of the other, to great depths; whereas, if an equal number of piles, or, better still, if a smaller number, but of larger diameter, had been driven in one tier, much greater actual stability would have been secured with greater economy.

The author then closes his paper with a short discussion of the effect of the "selective values of n′" which is more clearly shown, we think, by the table which will follow in our next issue, with an abstract of the more interesting portions of the full discussion, in which many members took part, and which requires too much space to appear in this issue.

THE LIVERPOOL OVERHEAD RAILWAY.

We have already described the principal features of this line, which is, we believe, the first metallic elevated railway built in Great Britain, in our issues of Sept. 5, 1891 and Jan. 30, 1892. At the recent meeting of the Iron and Steel Institute at Liverpool, which is elsewhere reported, a description of the road was presented by Mr. J. H. Great-

Section of Hobson's Patent Floor on the Liverpool Overhead Railway.

head, who is associated with Sir Douglas Fox as constructing engineer of the road. From it we extract the following additional particulars.

The method of erection adopted was to build each span (50 ft. length) with girders and flooring complete at an erecting shop on the north end of the road and transport it by a steam traveler running on the two outside rails to the end of the line, where a movable crane put it in place on the columns. The erection was carried on in this manner at a rate as high as 12 spans, or 600 ft. per week.

The Hobson flooring was described in our issues of Dec. 28, 1889, and Sept. 5, 1891. Some tests of the strength of this flooring were made as follows: A cross-section of the floor is shown in the accompanying cut.

Three sections of the floor, making a total width of 7 ft. 6 ins., were placed on supports 22 ft. apart and the load was equally distributed over four points corresponding to the positions of the rails. The following were the loads and the deflections:

Loads, tons	30	35	40	50	60	70	80	90	100	110
Deflection, ins.	0	⅛	3/16	¼	⅜	½	⅝	¾	1	1⅜	2

The plates ultimately collapsed by the rupture

of the T irons at 163 tons load with a deflection of 10 ins.

The method of construction of the floor is as follows: The flat plates are delivered sheared to exact length and width. Six of them at a time are heated in a long oven (to a cherry-red heat), whence they are separately hauled out endways into a hydraulic press, which bends them to the required shape. After cooling upon a grid or frame, where they are tightly held to prevent change of form, they are taken to a multiple drilling machine, which drills the requisite rivet holes (about 250) in two operations and in 15 minutes. After the end angle irons, for attachment to the main girders are added, the decking is completed by riveting mechanically the curved plates to the T irons forming the lower member.

Electricity will be distributed along the line by a steel conductor, placed on porcelain insulators, supported on cross timbers between the rails. Hinged collectors of cast iron sliding upon this conductor will take the electricity into the motor circuit.

At the start two-car trains will be run. Each car will seat 56 persons, and weighs 20 tons loaded; each car will have a motor at one end. The two motors will be controlled by one driver from either end of the train. There are 13 stations on the line and it is intended to make the six-mile run with the 13 stops in half an hour (about the speed of the Manhattan Elevated).

A very novel feature, for English railway practice, is the use of an automatic electric block signal system (Timmis') worked by the trains themselves, as noted in another column.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

XXIX.

Some Facts About the Profession of Engineering. The Am. Soc. C. E. Membership.

On the same circular on which we gathered the information as to the schools from which members of the American Society of Civil Engineers had graduated we obtained the following further information about the members, which, while it can hardly be called information about engineering schools, has an important bearing on their proper management, in addition to its general interest for engineers, and hence may better be given here than elsewhere.

Bearing in mind that the Am. Soc. C. E. is made up almost exclusively of successful engineers, i. e., of those who have followed the profession with (presumably) exceptional persistency to a better than average standing, it is a fact of no small significance that, roughly speaking, only half (51.1%) of the entire membership of that society have remained in engineering practice uninterruptedly. The remaining half branched off temporarily or permanently, into related occupations like contracting, corporate management, manufacturing and the like, for an average of one-third (35.1%) of their active life.

This is including all the members, both young and old.* Among the older men only (which ought properly to be the only class considered) the proportion of men who have branched out of engineering into some related pursuit is much greater, or 65.5% of the whole, only 34.5% of the older members have followed the strict practice of their profession throughout their active life. It is a safe prediction that no other profession whatsoever can show a tenth as great a proportion of members who leave it only for greater profit and not because they cannot succeed in it; for all these men had succeeded in it before they left it.

These facts are shown in detail in Table XXVIII. which (with the important note below it) sufficiently explains itself. The information on which it was based was gathered in response to the following question:

ABOUT how much of your active life has been spent in strictly engineering practice, and how much in other pursuits, such as manager, contractor, instructor, etc.?

The responses to such a query naturally presented many ambiguities. Some (not many) reported a variety of occupations, like teaching or farming, prior to their beginning practice as engineers. All such prior occupations have been neglected. Some reported "other occupations" into which they had been forced, as "Went to sea for my health as supercargo, 2 years," or " did (this or that) for a time after the panic of '73." All such (when they could be detected) have been neglected, and time thus spent included with professional work, the intention being to include among "other occupations" only those into which successful engineers were tempted by better emoluments than in the strict line of their profession. Doubtless some time thus included as "other" was not of this nature, but the chief source of error was in the opposite direction, viz., a tendency to class as "engineering practice" time spent in contracting, managing public works, etc. Therefore, we are confident that the table under states the actual amount of deviation into these latter pursuits.

* It includes also a few of the new class of Associate (corporate) Members, who hardly affect the totals, however.

Table XXVIII. Number of Members of the American Society of Civil Engineers (out of 668 reporting) who have passed their Entire Life in Strictly Professional Practice, and who have branched out from Engineering into Other Related Pursuits, as Managing, Contracting, Etc.

	Total No.	All Eng'g.	Partly other.	Mean p. c. "other" time.	P. c. members purely Engrs.
1867-69.....	29	10	19	41.0	34.5
1870-74.....	55	22	33	40.5	40.0
1875-79.....	65	35	30	39.3	53.9
1880-84.....	143	56	87	31.3	39.3
1885-89.....	239	132	107	29.8	55.3
1890-92.....	137	87	50	28.6	63.6
	668	342	326	35.1	54.1

Note.—In computing this table, time spent in bridge contracting, management of engineering ships, maintenance of ways, teaching engineering, editing engineering journals, and the like, which in one sense is strictly engineering practice and in another sense is not, has been rated as HALF engineering and half not. Time spent in ordinary contracting, railway management or manufacturing, has not been so rated as engineering practice in any sense, although the knowledge and training gained in engineering practice is admittedly called into play in them.

This is also a considerable class of employments which in one sense are engineering practice and in one sense not. Thus the candidate for the presidency this year has passed almost his entire life, since he graduated at Troy, in the management of a steel works at Pittsburg. If this is not "engineering practice," and in the highest sense, what is it? Yet in another sense it is mere business life. The same is true of a life spent in designing and building bridges, or managing maintenance of way, or managing any big machine works as a partner, or teaching engineering at a college, or editing an engineering journal.* Accordingly such a life figures in Table XXVIII., as half spent in strictly engineering practice, and half not; and proportionately for fractions of active life. The same was done with time as "manager and engineer."

Time spent in managing any department of a railway, canal or water-works, however, or in ordinary contracting or manufacturing, was not rated as engineering practice, though sometimes reported as such.

On the other hand, time spent as an employee of a contractor or bridge builder, or as an engineer officer of a corporation, or as a draftsman or surveyor, was in all cases classed as "strictly engineering practice," though often it is not. The rule was to exclude no more time from the latter class than was certainly proper.

It was to be expected that, as Table XXVIII. shows, the younger men would appear to stick to their profession much more closely, because they must have had an average of ten years or so of professional practice to get into the society at all, and the opportunities which tempt them out of it come only as the result of such experience. Nevertheless, of the members and (a few) associate members who have entered the society since 1890, one-third have already passed 28.6% of their short professional life in "other" pursuits.

If these things are true toward the top of the profession, how is it with the average of the whole? It is obvious that the percentage of members must be much greater; and as they chiefly go into various kinds of executive and administrative positions, the importance of remembering that possibility, so far as may be, in their professional training is plain.

The information in regard to the extent to which engineers make enforced changes of residence, presented in Table XXIX., was gathered in response to the following question:

In what different states or counties have you had professional engagements of say three months or more?

In asking this question and the former one already given, they were stated to be for the purpose of ascertaining "to what extent engineering is made a more attractive profession by the opportunities for changing into other employments which it gives; and to what extent it is made less attractive by enforced changes of residence." The bearings of the last remark have been in a number of cases strangely misunderstood. It was not intended to imply that "enforced changes of residence" were not a pleasant and (often) profitable experience in themselves to any young engineer. We all know that they are, and a number of members have taken pains to say so. But on the other hand, these frequent changes are an immense disadvantage to the young engineer in preventing him from establishing a profitable connection on which he lives in later life, as does the physician or lawyer or architect. Those who have once known a member of the latter professions and want him know where to find him ever after; but who knows where to find the engineer whom they employed a few years before? They may and do hunt him up at times, especially as he rises in the profession, but the young engineer not only suffers much from this difficulty, but (especially if he be married) is put to much expense by these transfers.

* The total amount of time of members which has been spent in teaching or editing is not such as to materially affect the totals. The bulk of the wanderers go into some kind of executive position.

Table XXIX. Number of Different States or Countries in which the Members of the American Society of Civil Engineers have had Professional Engagements of Three Months or More.

Diff. States.	Admitted '67-9.	'70-4.	'75-9.	M. Am. Soc. C. E. in '80-4	'85-9	'90-2	Total	P. C.
1	2	4	10	21	25	15	77	11.5
2	..	8	4	14	24	16	66	9.9
3	6	10	10	19	45	28	118	17.7
4	3	6	9	9	35	22	84	12.6
5	10	8	6	16	24	16	80	12.0
6	3	6	3	15	25	11	63	9.5
7	..	1	7	12	18	11	49	7.4
8	3	2	6	13	9	5	38	5.7
9	..	4	3	6	10	5	28	4.2
10	2	..	..	4	5	3	14	2.1
11	..	3	2	..	7	1	13	2.0
12	..	..	1	5	4	..	10	1.5
13	..	..	..	2	4	..	6	0.9
14	..	1	2	1	1	1	6	0.9
15	..	..	..	2	..	..	2	0.3
16	..	..	..	2	..	1	3	0.5
17	..	..	..	..	..	..	..	....
18	..	..	..	..	..	..	..	....
19	..	1	..	..	..	..	1	0.1
20+	..	..	2	1	3	2	8	1.2
Total.	29	54	65	142	239	137	666	100.0

Table XXIX. shows in brief that:

⅛ (12.7%) of successful engineers have lived for three months or more in 9 different states or countries.
¼ (25.8%) of successful engineers have lived for three months in 7 or more states or countries.
⅓ (35.3%) of successful engineers have lived for three months or more in 6 different states or countries.
½ (47.3%) of successful engineers have lived for three months or more in 5 or more states or countries.
⅔ (59.9%) of successful engineers have lived for three months or more in 4 or more states or countries.
¾ (77.6%) of successful engineers have lived for three months or more in 3 or more states or countries; and only 11.5%, or about 1-9, have had their residence in only 1 state.

This statement leans to the conservative side in every way, the most important being that the number of changes of residence is, as an average, about twice as great as the number of different states. Thus one member, who reports all his professional life as having been passed in one state, reports five different places of residence within that state. Several others give tables showing the number of changes of residence, which in every case foots up about twice as many as the number of states or countries. The whole of Canada was counted as but one country, except in the case of Canadian members, where the separate provinces were considered. In a number of cases where members reported that they had had professional engagements of three months or more in "all" such and such a group of states, a much smaller number, usually half, was taken, as more fairly representing the point aimed at. Army engineer officers, who change about a great deal, were counted for five states only. One member gives a list of 35 different states or countries in which he has had engagements.

One case in the opposite direction is so curious and so exceptional that we venture to refer to it by name. We apprehend that it is the only one in the society. Mr. Wm. Pierson Judson, of Oswego, N. Y., reports: "Engineering practice ex-

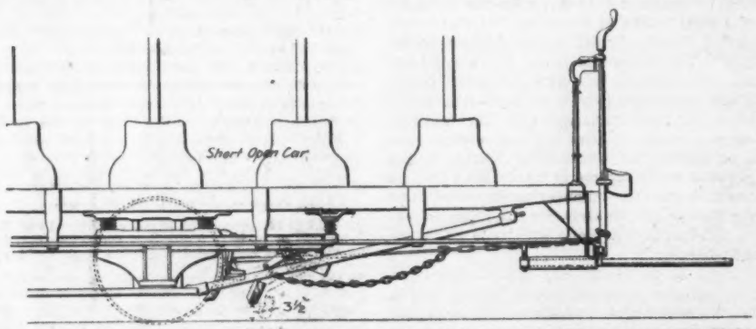
clusively for 27 years with office and home always at birthplace." There may be two or three cases of members living in large cities, but we know of none, and the cases where members even live now in the same state where they were born are the rare exception. Out of all the members reporting who joined the society prior to 1890, only 26.7% (141 out of 531) live in the same state as they were born in, chiefly in New York, Pennsylvania and Massachusetts, which afford (two of them) a great interior area for migration, and all of them a great variety of engineering employment. The proportion would not be much greater if the names were drawn out lottery-fashion, with names and birthplaces in one wheel and an equal number of names of states, apportioned in proportion to the chances they offer to engineers, in another wheel.

THE LATEST REPORT ON STREET CAR FENDERS.

In our issue of Feb. 21, 1891, we reported the results of the investigation and experiments made by the Massachusetts Railroad Commission to determine the best form of fender for electric cars. Briefly, the results then obtained showed that it was virtually impossible to design a satisfactory fender for four-wheel cars, since it had to be placed about a foot above the rail to allow for the see-saw motion of the car on rough track. Largely on this account the Commission held that it was the duty of the West End Street Ry. to do its own investigating of the subject of fenders, for the responsibility in case the proper action of the device was prevented by the design of the car would then rest where it belonged.

In accordance with this report the Massachusetts Legislature in 1891 repealed the law making the prescribing of a fender the duty of the Railroad Commission, and President Henry M. Whitney, of the West End Street Ry. Co., at once appointed a Commission to recommend a form of fender for use on the cars of his company. The members of this commission were Messrs. Thos. C. Clarke, C. E. A. Bartlett, and Geo. F. Swain. Prof. Swain was the engineer expert in charge of the former tests for the Railroad Commission.

The report of this Commission, which has just been made public, recommends the adoption of the Cleveland platform and buffer, the invention of Mr. Thos. L. Johnson, President of the Cleveland City Ry. Co., in combination with a movable fender invented by Mr. L. J. Hirt, Master Mechanic of the West End Street Ry. The arrangement is shown in the accompanying drawing. We extract the following from the Commission's report:



FENDER RECOMMENDED FOR ELECTRIC CARS OF THE WEST END STREET RY. OF BOSTON MASS.

No less than 211 fenders were presented to the Commission for examination by plan, model or description.

It was found upon examination that all the fenders which were brought to the attention of the Commissioners could be divided into three classes, viz.:

A. Buffers which soften the blow given by the car to the person, and pick him up in a net.

B. Platforms which project beyond the dashboard of the car, and upon which a person could leap, or, standing up, could be caught and carried along.

C. Fenders which are placed below the car platform, and whose object is to push along a body lying down upon the tracks, and prevent it from getting under the wheels.

After careful examination of all the devices, it was decided to make experiment with certain ones upon dolls or dummies made, as nearly as was possible, of the size, shape and weight of a man, a woman and a child; 43 fenders were, therefore, constructed of full size, and attached to the cars of the West End Co., and experimented with.

Several different kinds of fenders were also attached to cars in regular service; and the Commission examined written evidence upon the use of fenders in Kansas City, Cleveland, Rochester and other places.

We believe that the safety of the public can be increased by the adoption of two devices as follows:

1. A platform projecting in front of the car platform, known as the Cleveland platform. This has been modified by the officers of the West End Co. to enable it to be slid under the cars, or under the rear of any car, when it is not in use.

This device appears to us to be preferable to any of those included in Class A (of which several very ingenious examples are submitted, and experimented with), on account of its greater durability, simplicity and certainty of action, and on account of its not being liable to get out of order.

In addition to this platform, there should be an elastic buffer, made of stout wire or metal strips, and curved so as to project from the front dashboard and receive, on a yielding surface, the blow of a person's head and shoulders. This buffer could, if desired, be easily detached and changed from one end of the car to the other. The meshes of the buffer should be large enough to enable a person to seize it with his hands.

2. The second device, which is in Class C, is to prevent a person who has fallen down, and is lying on the track, from being run over by the wheels. These fenders can be constructed as follows:

A. Where they are supposed to be always ready to catch the body of the person. This requires that they should be fixed. Our experience shows that if fixed high enough to avoid the usual irregularities of a street track, they would pass over an arm or leg or a small body lying upon the track. If low enough to prevent this, they would soon be injured or destroyed in regular service. This class of fender, therefore, does not seem to us to be effective.

B. Where they require the action of springs, levers, or some other device which is operated by the force of the blow struck against the body. These are open to the objection of being complicated and easily thrown out of working order. They would probably be found inefficient when wanted. No device has been suggested to us which overcomes this objection, and, moreover, no fender of this kind has shown itself efficient in our tests. We, therefore, do not feel that we can recommend a fender of this class.

C. The third class comprises those fenders which are set at a height sufficient to go above ordinary projections, and which are forced down by the motorman to the track level when wanted; of these, two kinds have been considered.

The first is operated by the motorman by the movement of a separate crank handle or other device. Such fenders require on the part of the motorman three separate operations in a very short time: viz., to shut off the power—put on the brake—put down the fender. In the face of imminent danger, the motorman would be likely to get confused, and omit to put down the fender in time; and we feel that a great objection to such fenders is that they impose too much responsibility on the motormen, who already have enough. We, therefore, believe that this mode of operating a fender is not desirable.

A second mode of working the fender has been submitted to us by Mr. L. J. Hirt, Master Mechanic of the West End Street Railway Company, viz., the turning of the brake handle first applies the brake, and then lowers the fender down to the track. The action may be made so quick, however, that the two movements appear nearly simultaneous. This device has no parts that would seem liable to get out of order. It has shown itself, under test, at least as efficient as any other fender. Its operation insures the maximum safety to a body lying on the track, and it imposes no additional duty or responsibility on the motorman in addition to those which he now has.

We, therefore, recommend that the Cleveland Platform with buffer, combined with the Hirt fender, operated by the brake handle, be attached to both ends of all the electric cars of the West End Ry..

In accordance with this report President Whitney has notified the Boston Board of Aldermen that if no objection is made the West End Co. will proceed to equip its cars with the above fender as rapidly as possible. The Johnson platform is also in use and is giving excellent satisfaction on the cars of the Cleveland City Ry. Co., the Southern Ry. Co. of St. Louis, the Johnstown Passenger Ry. and other lines.

A MODEL ELECTRIC STREET RAILWAY ROADBED AND UNDERGROUND WIRING.

The following is the substance of the report of Mr. Geo. W. Baumhoff, committee on the above topic, to the Cleveland Convention of the American Street Railway Association:

Survey.—Provide for all curves the longest possible radius at the ends; elevate the outer rail 1 to 2 ins. higher than the inner, where the condition of the street will permit. Short radius curves and those located on a down grade require the greatest elevation. Switches or cross-overs should be located at such points as will best provide for bunching cars for large gatherings, and keeping cars moving during fires, parades, etc., when the terminus cannot be reached. Switches should preferably be on up grades, enabling cars to cross to the opposite track by gravity; but they should never be placed with the point against the traffic. In ordering cross-overs, specify the straight track rail to be continuous, to favor the track most used. The usual practice is the reverse of this.

Excavation.—The following plan will not only provide a suitable sub-drainage, but insure permanency: Remove all earth to a depth of 8 ins. below the bottom of the cross-tie the full width of the trench; then roll thoroughly with a heavy four-horse or steam roller; then spread with a layer of cinders, crushed rock, gravel or furnace slag, from 6 ins. to 8 ins. in thickness, and again roll until the same is well bedded and leveled. A trench 7 ft. in width, with 8 ins. of ballast, will require for one mile in length 24,640 cu. ft. of material; estimated at 3½ cts.=$862.40; and will require the removal of 912 cu. yds. of earth, estimated at 25 cts.=$228; add for rolling, $50. Total, $1,140 per mile of single track.

The fact that the material so placed provides a splendid sub-drainage is the best argument in its favor, and one that will commend its adoption where soil demands it; for it must be remembered that it is far more expensive to open up and re-tamp poorly constructed track than to properly construct and provide with sub-drainage at the outset. For surfacing, care should be taken to procure machine-crushed rock or gravel, as it insures a more even bed under the tie than coarser material.

Cross-Ties.—The long life of a wood tie when buried to a depth of 8 ins. or more is the best argument in favor of its adoption instead of metallic ties. In selecting the kind of wood for ties, attention should be paid to the spike holding power as well as to durability. White oak is especially good in this respect. Ties should be at least 5×8 ins. for rails of 56 lbs. and upward, and should be laid as closely as will permit good tamping; say, 27 ins. c. to c. A wide tie at the joint where wide joint chairs are used is better than two narrow ties, which cannot be thoroughly tamped. If smaller than 5×8 ins. must be used, the decrease should be in thickness rather than width to avoid splitting, caused by driving the spike too close to the edge.

Rail.—The success of the permanent way depends largely on the rail, which should be strong, durable and capable of making good joints. The strength depends chiefly on the weight and on the height and thickness of the web. For making good joints the girder rail possesses peculiar advantages, and to this fact it owes its almost universal adoption. The durability depends on the height of the head of the rail at the gage line above the lower flange, and on the quality of the metal. Steel is now invariably used for rails; but street railway companies, unlike steam railways, specify nothing in purchasing rails concerning the quality of metal. The rail over which electric motors are operated through crowded city streets is certainly subject to as much if not more wear than the rails of many trunk line railways. As we have patterned closely after steam railway practice in other matters, we may do so profitably in this.

Of the various forms of the head, the centre-bearing rail is the most desirable, because, with a lower train on each side, the head is kept free from dirt, and consequently offers less resistance to the car wheels.

In many localities the use of this form of head is prohibited. This was at a period, however, when cars were operated by animal traction, and when at least 75% of all vehicle traffic along streets where cars were run were accustomed to use the track. If there ever were any valid objection from this source, the introduction of rapid transit has certainly overcome it; for drivers of vehicles generally shun the tracks of roads operated by rapid transit. The public now demand that the quickest possible time be made in transporting them to and from their homes and places of business; and where once the unruly teamster held sway for blocks at a time, ahead of a slow-going horse car and patient passengers, he is now compelled by the change of motive power and a strong public sentiment, to keep to the right as the law directs. What is therefore of most service to the railway company, is likewise beneficial to the public; and your committee would earnestly recommend in communities where objection is made to the use of the center-bearing rail, that the authorities be asked to give the subject careful consideration and at least attempt a comparative test. We claim that the center-bearing rail does not impede vehicle traffic, nor would it be objected to by owners and drivers of vehicles when properly laid, to the extent of prohibiting its adoption.

Next to the center-bearing form of head, the side-bearing head is by far the most desirable from the operators' standpoint; for the only other form made of the girder type is that with a groove instead of a lower flange. The latter form of head is suitable only for curves and cross-overs, when rolled with a wide groove, and should never be adopted for straight track, owing to the tendency of the groove to hold dirt, snow and ice.

In the selection of a girder rail of any form of head, and more particularly the style known as side-bearing, it would be well to remember that the rail having the widest base offers the greatest resistance to turn over; and care should therefore be exercised in the selection of the rail to secure the widest possible foot. This subject requires no argument to demonstrate its necessity, and your committee would urgently advise enlarging the rolls at the base of the rail, in order that the same shall at least equal in width the combined width of the tread and lower flange.

Chairs.—The use of a chair, the only purpose of which is to provide for the required height to the top of the rail for paving purposes, is not recommended. It is much better to secure this height by the adoption of a rail having a higher web, thus enabling the rail to be spiked directly to the cross-tie by means of a tie-plate, which tie-plate should be provided with a brace extending upward to the bottom of the outer head of the rail, to prevent the rail from turning. Where a plain tie-plate is adopted, a cast iron brace should be spiked to each tie. No girder rail should be laid without making provision to prevent it from tipping, and the above plan, being more economical than the use of a tie-rod, is preferable, as its bearing at the upper portion of the rail is more serviceable in checking the strain than a tie-rod secured through the web of rail.

If chairs are required, care should be exercised in selecting such as will insure the greatest possible bearing on the tie, and such only as will not spring under heavy loads. A chair with a narrow base is apt to cut into the cross-tie, and in time will work loose or cause the rail to cant. All intermediate chairs should be provided with a brace extending well up under the outer head of rail, which is the best safeguard against the rail turning or canting.

Joint Supports.—Your committee would very urgently recommend the adoption of such joint supports only as are of sufficient length to cover at least two ties; but we consider a bearing on three ties preferable. The holes in the web of the rail should be not less than 1 in. in diameter, to admit the use of a bolt having a large size nut, which should be tightly secured by the use of a hammer and wrench. A six-hole fish-plate of sufficient height to reach from the foot of the rail to the bottom of the head, 26 ins. or over in length, securely fastened with large size bolts, is considered by many who have used it to be superior to all other joint fastenings.

Cars operated by electricity are not only heavier than horse cars, but are operated at a much higher rate of speed, and require the most thorough construction. The slightest spring or looseness will gradually result in a low joint, which, if not soon attended to, will ruin the end of the rail beyond repair. It would therefore be well to relieve the fish-plate of much of this strain by providing a support for the bottom of the rail extending over two or more cross-ties.

The rails may be closely joined when laid in hot weather, but if laid at low temperature, proper allowance should be made for expansion.

There exists among railway managers a difference of opinion as to the merits of supported and suspended joints. Your committee earnestly recommends the supported joint, with a support for the bottom of the rail extending to the adjacent ties, and does not deem it advisable to adopt the suspended joint construction, unless the joint support has a firm bearing on the adjacent ties. There are a number of such joint chairs of various manufacture now in use, which your committee are reliably informed are giving entire satisfaction.

There is also a diversity of opinion as to the location of rail-joints with respect to each other, and on this subject we do not hesitate to take a firm stand in support of the joints being laid directly opposite each other, when constructed for electric traction, as the tendency where laid with broken joints is to cause the car to sway sideways, particularly at a high rate of speed, if the joints are not kept extremely perfect. The former plan renders it also more economical to repair joints, especially in paved streets.

Paving.—Paved streets are preferable for the street railway company as well as for the public. It is impossible to build a track entirely non-obstructive in unpaved streets. Furthermore the paving helps to hold the track to gage and protects it from being cut down by passing vehicles. The rail being much cleaner than in dirt streets effects a large saving in the current required for the operation of the cars. Granite paving is more durable, costs less to maintain and to remove and replace in repairing track than asphalt, brick, wood or Telford. Asphalt paving tends to wear in ruts alongside the rail; and where a street railway passes through an asphalted street, a double row of granite blocks should be laid next to the rail. This also permits the free vibration of the rail and makes it more easily accessible for repairs. Wood paving, which has been more or less used beside street railways, has sometimes closed the slot in a cable railway by its expansion when wet.

With girder rail construction it is advisable to fill in the web of the rail with moist clay just before paving in order to prevent the paving blocks from working loose by the sand surrounding the blocks working into the space just mentioned.

Sometimes an iron frame is constructed at each joint to provide for repairs thereto without disturbing the paving. With the latest girder rail joint construction, however, with ties well tamped and bolts securely fastened, there is no necessity for such a construction.

Underground Wiring.—As all this work is underground, out of sight, and with paved streets made inaccessible without incurring large expense to repair and renew, the most thorough workmanship and best material should be adopted.

The object to be accomplished is to form a perfect connection from each rail along the road to the poles of the generator at the power house; the ground wire being connected to the negative poles, and the overhead wire to the positive poles of the machine (although we have heard of the reverse being the rule on some lines).

A large-size insulated copper wire is generally adopted to form the connection between the generators and such points along the track as it is deemed advisable to reach. The return circuit may be completed, either by connecting said wire to the rail, or to a supplementary wire extending the entire distance of the track. The latter is in all cases recommended, and it should invariably be soft copper wire, not smaller in size than No. 0. In either event, however, all rail joints should be bonded with a soft copper wire not less in size than No. 6, and if the supplementary wire is laid, a connection thereto should be made to at least every fifth rail. It will also be of great advantage as a safeguard against any possible break in the circuit, to connect both sides of the track with a No. 6 wire; and if a double track, to cross to the opposite track, and to the supplementary wire in said track, at least every 1,000 ft.

We have heard of instances where copper wire laid underground was more susceptible to electrolysis than wire of galvanized iron or steel; but, after a thorough trial of upward of three years, during which time we have used both, the conclusion reached is, that copper being not only a better conductor, but less liable to corrode and break, is therefore the best wire to use for underground work. Galvanized soft steel, or iron wire, used for this purpose, has not proved durable, and we have found it entirely eaten away by electrolysis where it had come in contact with the cross-tie, although in perfect condition elsewhere. The only theory we can advance to account for this is, that a chemical action takes place between the gases of the soil, precipitated by the sap contained in the timber and salt water—the latter from the use of salt for the purpose of melting snow and ice,—although such results have not been noticeable in the use of copper wire.

In addition to cross-wiring, as above mentioned, it will be found advantageous to the economical operation of an electric railway, to excavate or bore to a sufficient depth to secure continual moisture. Where such grounds are located, care should be taken to make the best possible connection to the supplementary wire and the track.

By a careful examination of the ampere meter at the power house during dry weather and rainy weather, it will be noticed that there is a marked decrease in the amount of current used in rainy weather. It follows that the more perfect the connections of the rail and the opposite poles of the generator with the moist earth, the more economically is the system operated.

It must be remembered that the saving in current in wet weather over dry weather, is due also to the fact that the dust and dirt, which readily finds lodgment on the rail, is washed off. Many electric roads have found advantage in the use of a car equipped with a tank having one down-spout, about ⅝ in. in diameter, on each side, so arranged as to permit a stream to flow over the head of each rail. These down-spouts should be located as near the wheel as possible, in order to insure the same being directly over the rail at curves, as well as on the straight track.

Discussion.—At the session on Wednesday evening, an extended discussion took place on this paper. Mr. Payne, of Milwaukee, said that he had used the girder rail on chairs and had about 20 miles of that construction a year ago. He then began laying 8-in., 88-lb. rail spiked directly to ties spaced 20 ins. c. to c. The rail on the chairs has not proved satisfactory and is being replaced. The new construction is very satisfactory and one can hardly tell where the joints are.

Mr. Littell, of Buffalo, said he had lately contracted for 20 miles of track, with the privilege of increasing it to 30 miles and would use a 9-in., 93-lb. girder rail without chairs; the splice-bars are ⅝ in. thick and 32 ins. long, held by 12 1-in. bolts. The tie rods are spaced 5 ft. apart and the ties 3½ ft.; the latter are 5×7 ins., 8 ft. long, yellow pine or oak.

Mr. W. J. Richardson, of Brooklyn, said his company had recently laid 12 miles of 70-lb., 6-in. rail with 4½-in. base, on chairs. The ties are 5×9 ins., 7 ft. long, 2½ ft. c. to c., long leaf, untapped Florida pine. Under each joint is laid a special joint support about 36 ins. in length of 40-lb. T rail reversed, supported by chairs. He had not yet operated this line with electric motors, but thought when laid that it was a perfect track. Since then, however, he had decided on something better and is now laying a 90-lb., 9-in. rail with 5-in base on the same sort of ties. At each joint a 6×12-in., 7-ft. tie is laid, and the splice plates are 26×⅝ ins., held by eight 1¼-in. bolts. In his opinion, no space should be left at the ends of the rail for expansion as recommended above, but a perfectly close and tight joint should be made.

Mr. Hurt, of Atlanta, said his experience was that it was not the size or strength of the rail, but the strength of the joint, which was important. He used a 7-in. rail on stone bearings.

Mr. Littell favored an 8-in. rail, without any chairs. He considered chairs a delusion.

Mr. Pearson, of Boston, said he had not yet found a perfectly satisfactory joint, but thought the Johnson girder joint was the most promising one. He thought one fault inherent in any girder rail laid on ties was that the ties would be cut into very rapidly by the rail. He thought that unless a broad plate 10 or 12 ins. × 6 or 8 ins., was laid under each tie the deep girder track would eventually go to pieces as the lighter construction had done. With the 6-in. girder rail, laid on a stringer with the Johnson joint or something similar, the whole base of the rail is effective bearing surface, and there is no cutting into the ties. If 10-in. rail is used, splice plates 36 ins. long will be necessary, with at least 12 bolts to a joint. It is very important that abutting rail ends should be of the same height. A difference of 1-16 in. or even 1-32 in. will cause a bad joint, no matter how strong the fish plates.

Mr. Henry, of Pittsburg, thought the improper construction of trucks was a chief cause of the failure of joints. Nearly all trucks have great dead weight on the axle-boxes. Half of the weight of the motor and all the weight of the truck goes down on the rail like a sledge hammer when an obstruction is met. A weight of four or five tons hammers the rail end, and every time it is hit it goes lower. This impact must be done away with. His company is putting an elliptical spring on top of the axle box and suspending the whole weight from this spring so that the axle-box can work up and down as it comes to elevations or depressions in the track.

Mr. Lawless, of Paterson, believed the deep rail was required with electric cars. One cause of trouble with joints was defective tamping of the joint tie.

Mr. Wharton, of Philadelphia, said that if it were possible to use a T rail, nobody would use anything else, but the companies are obliged to do what the local authorities direct. A point in the joint question often overlooked is the proper tightening of the bolts in forcing them home. After they have been once tightened up they should be removed and the oxide cleaned off and then they should be replaced and tightened. Two or three months afterward they should be screwed up again. The steam railways are continually tightening up their joints, but it is not so easy on a street road.

Mr. A. Johnson, of Cleveland, thought good ballasting was the chief thing in securing good track.

Mr. Beckley, of Rochester, said he had an electric suburban road laid with 40-lb. T rail which had been in service for three years, and he believed no one could ride on the cars and count the joints. He had heard a great deal about girder rails 8, 9 and 10 ins. deep, but he did not believe in that kind of construction. His

company had constructed 130 miles of road in the past three years and had been operating electric cars nearly two years. He thought the best track which could be laid for electric traction was a rail of 52 to 60 lbs., 4½ to 5 ins. deep, laid on stringers, vulcanized if possible, and these on ties 2½ ft. apart. The stringer should be 6 ins. wide so that the paving could be placed without interfering at all with the track construction. He had constructed such a track recently and expected to find it doing its work when a great deal of track described by previous speakers was up for repairs.

Mr. Ramsey, of Pittsburg, said that his plan was to put as good construction under the whole length of the rail as is used under the joint.

Mr. Baumhoff, of St. Louis, said, with reference to the provision for expansion, that in laying two miles of 78-lb. rail in St. Louis, he had placed the ends as close together as possible, but would not advocate that for a rail of less weight or shallower depth.

Mr. Janney, of Philadelphia, said one cause of bad joints was relying too much on the fish-plate. Sometimes the holes in the rails cut through the bolts. He could not believe that a 10-in. rail was any better than a 6-in. rail. He had been running a 10-ton dummy hauling a trail car over a 66-lb. rail for 18 months, and in an unpaved street.

Mr. Wason, of Cleveland, said that, to get as near as possible to a continuous rail, he had in the early part of the present year laid about 1,000 ft. of track putting the ends of the rail as close together as possible and securing each joint by six red hot rivets. The joints were first put together with bolts and pulled home, and the bolts were then taken out and the rivets inserted. The rail was 56-lb., spiked to the tie. This was done on a suburban line which has not a very heavy traffic, the object being to see whether the summer would have any effect in twisting it or throwing it out of line. This track was put down in March. It is as straight now as when first put down, and the joints are absolutely imperceptible. In his opinion, so long as dependence was placed on bolts, which are bound to work loose in time, there will be trouble with track. He did not know what effect the winter would have upon this track; but the hot weather had no effect on it.

Mr. Pearson said it had always seemed to him that a good joint might be secured by riveting. He had tried joint-boxes for making joints accessible, but found that as a rule when the bolt had to be tightened the tie needed tamping, and the pavement had to be taken up anyway; so the joint boxes were of no particular use.

COMPARATIVE COST OF ELECTRIC AND CABLE RAILWAYS.

A report on this topic was presented to the Convention last week of the American Street Railway Association, giving detailed statements of the operating expenses of seven electric and eight cable railways. Tables giving similar information will be found in our issues of May 23 and Oct. 24, 1891. The present statistics agree with the previous ones in indicating a less total cost of operation for electric railways than for cable railways. Of course the variations in the circumstances under which different lines are operated and in the method of keeping accounts throws some doubt on statistics of this sort; but in the principal thing indicated—that the return from a given investment in a street railway system is greater with the electric system than with any other form of motive power, all the statistics seem to agree. The accompanying table is re-arranged from the one presented at the Cleveland Convention. It was commented on as follows in the report:

The quality of the management which any of our roads receives is an uncertain quantity, but must be assumed to be good, in our arguments. The management of cable roads Nos. 1 and 3 is known to the writer to be excellent. The other conditions under which the two roads operate are nearly the same. Yet a "figure of merit"—obtained by multiplying the total daily mileage by net earnings per car mile, and dividing by the amount of capital stock paid in, shows vastly in favor of No. 3 road, and this, notwithstanding the gross operating expenses of No. 3 road are about 50% higher than the operating expenses of No. 1 road—both being placed on an equal basis of grip car miles. We see, therefore, that still another method of comparison must be resorted to in order to give an intelligent idea of the comparative earning power of two roads—namely: the comparative earning power per day of each dollar invested in each road. This ratio, when stated, comprehends all of the conditions under which the two roads operate; it is the final result of a compound proportion of which the ingredients are the investment, the outlay and the income—"outlay" comprehending the management and efficiency of the road, and "income" comprehending, among other things, the comparative value of the territories through which the roads pass.

Operating expenses per motor car mile, or per grip car mile, afford a satisfactory basis on which to compare expense of operation, but net earnings per motor or grip car mile tell us nothing of the value of a road as an investment, unless we know also the total investment necessary to earn so much per car mile; and we take occasion to remark here that future committees on this important topic will find it discouraging work to follow the usual lines of investigation into receipts, cost of operation and net earnings of street railways, and may find it necessary to look to some method of comparison by arbitrary "figures of merit," as has been suggested by several of our thinking engineers.

For a comparison of an average cable road with an average electric road, let us take this same No. 3 cable road, and compare it with electric road G. The cable road has been shown to be something better than the average, and the electric road is known to the writer to be at least up to the average. These two roads afford us a better opportunity than any other two which we might select, for the following reasons: Both are located in the same city, where climatic and other local conditions are the same. Both roads are of the same magnitude. Fuel and labor cost the same in each case. Neither road operates trail cars.

The cable road has the advantage in route as to grades and curves; otherwise, the roads offer excellent opportunities for comparison. It might be added that the investment in each case is up to the average; that is, is not extravagantly large, and yet is ample for the business transacted. Each road may be regarded as typical of its class. We see, upon examination, that the cable road has the greater fixed charges by 1.7 cts. Resorting again to the comparison by "figure of merit," we find a ratio of .00015 to .00020, or nearly 3 to 4 in favor of the electric road. This simply means that each dollar invested in the cable road will earn .00015 ct. in one day, whereas, each dollar invested in the electric road will earn .00020 ct. in one day. The total investment in the case of the cable road in this case is 2⅛ times the total investment in the case of the electric road. The capital stock alone, exclusive of bonds of the cable road, is 2.4 times the capital stock of the electric road.

What is our conclusion from these facts, or can we draw a conclusion on which we can stand? We have not been conservative in our statements thus far, but are, of course, not infallible. "One swallow does not make a summer"—nor do the examples we cite determine the matter once for all. The cable road has its place firmly established in the transportation business of the Pacific Slope, and we, who are unacquainted with the conditions met with there, cannot presume to say that the electric railway would do the same work better and more efficiently. We are tempted to say so, but the interests concerned are too great to be trifled with in so dogmatic a manner. Another year may develop such improvements in methods of accounting, that definite conclusions can be formed; but to do more than merely produce figures from typical roads, the Committee is not prepared at this early stage of electric railroad practice. The cable roads have their methods pretty well digested, and their figures are, as a rule, reliable. The electric roads are as yet with few exceptions, published in this paper, in the dark as to what they are doing—except that they have enough left to satisfy stockholders—in fact, 89% of the electric roads heard from, report dividends of from 5 to 12%.

We believe that cable road practice has reached the stage where but little room is left for improvement. They have been developed, improved and operated by the best engineering skill which the country affords. Nearly all are on a good dividend-paying basis; but whatever the past experience of the two systems has been, or whatever the present status of the two may be, we are only voicing the convictions of well-informed engineers when we say that electric systems will continue to increase in efficiency (by which is meant earning capacity), until all rivals are distanced, and only one method of rapid transit is recognized—the electric car.

Details of Operating Expenses of Eight Cable Railways and Seven Electric Railways.

	Eight Cable Railways								Seven Electric Railways						
General Characteristics:	1	2	3	4	5	6	7	8	A	B	C	D	E	F	G
Average No. of cars { Grip or motor operated daily.	193	30½	54	6	7	29	8	70	39	17	280	10	10	5	37
Average No. of cars { Trail	298	....	....	6	7	58	5	70	....	....	5	4	....	....	....
Average daily mileage { Grip or motor per car.	80	127	100	90	70	104	90	123	127	89	70	120	100	97	100
Average daily mileage { Trail	80	....	....	90	70	104	106	123	....	....	56	120	....	....	....
Wages, conductors and motormen, cts. per hour	23	17	18¾	17½	....	20	22½	22	15½	24	22½	12½	13	14	20½
Cost of fuel per ton, $	1.47	2.02	1.21	2.00	....	....	....	6.20	2.45	....	3.92	1.25	1.32	3.00	1.21
Financial results; cts. per car mile*															
Total receipts	18.05	18.30	29.84	15.10	19.80	....	....	....	19.36	25.26	40.28	13.50	15.00	....	28.88
Total fixed charges	1.62	4.70	5.44	....	....	1.23	1.88	6.61	....	7.22	3.36	9.00	6.40	....	....
Total operating expenses	8.84	13.70	16.00	41.00	....	6.75	10.71	20.05	9 69	17 97	25.44	9.00	....	16.00	18.53
Total net earnings	7.62	4.90	8.40	....	....	....	....	....	9.67	....	14.34	4 00	3.42	5.23	6.61
Details of fixed charges:															
Interest on funded debt	1.06	4.20	3.20	....	0.66	0.99	1.53	5.70	....	6.86	1.00	....	....	....	2.56
Total taxes, except water	0.55	0.50	2.24	....	1.21	....	0.35	0.61	....	0.36	2.36	....	....	....	....
Details of operating expenses. Maintenance of:															
Roadbed and track	0.40	0.50	1.91	....	....	....	0.45	0 40	....	0.77	2.52	....	....	0.11	2.50
Cable or line work, underground machinery or wires	0.69	2.30	1.72	....	....	....	0.73	3.00	....	0.20	0.72	....	....	0.07	0.52
Power plant (repairs of engines, etc.)	0.53	0.10	0.19	....	....	....	0.05	0.12	....	0.41	0.36	....	0.42	....	....
Plant in general (buildings, etc.)	0 13	0.03	0.58	....	....	....	....	0.10	....	0.01	0.33	....	....	....	....
Rolling stock	0.59	0.30	1.03	....	....	....	0.48	0.86	....	3.40	1.59	....	1.23	0.74	2.36
Grips or motors (inspection and repairs)	0.08	0.10	0.57	....	....	....	0.56	0.54	....		2.72	....	2.36	....	2.38
Other details of oper. expenses:															
Power (fuel, oil, waste, wages)	0.92	1 70	1.07	....	....	....	2.53	3.24	....	3.30	3.56	....	3.20	3.84	2.84
Conducting transportation (wages of carmen, starters, etc.)	4.70	6.40	7.45	7 00	....	....	4.98	9.89	....	8.75	11.42	1.50	....	8.74	6 90
General expenses (salaries, legal, accidents, etc.)	0.76	2.00	1 48	3.00	....	....	1.22	1.90	....	1.09	2.22	....	....	0.62	2.21

* Including mileage of trail cars.

NOTES FROM RECENT WATER-WORKS REPORTS.

The average daily consumption of water per inhabitant in Philadelphia in 1891 was 140 gallons, according to the last report of Mr. John L. Ogden, Chief of the Bureau of Water. This consumption is based on an estimated population of 1,071,672, the census returns for June, 1890, having shown a population of 1,046,000. The consumption in 1882 was only 76 gallons, the population being estimated as 890,000.

The cost in 1891 per million gallons pumped 100 ft. high was $2.99, and in 1882, $6.66, the total amounts pumped to an equivalent height of 100 ft. having been 93,490,106,725 gallons in 1891 and 37,873,303,258 gallons in 1882. For coal alone the cost of raising 1,000,000 gallons 100 ft. was $1.63, against $1.92 the previous year. This reduction was caused by the substitution of washed buckwheat anthracite for pea coal, the average price of the former having been $1.80½ and of the latter $2.05 per ton. The change in coal necessitates no change in grate bars.

Of the total pumpage of 1891 about 94% was from the Schuylkill and 6% from the Delaware River, while 20% of the total was raised by water power, 5% less than in 1890.

Some interesting observations on the consumption and waste of water in three selected districts of the city were made during the year. The results of these observations will be given in a later issue.

There were in use at the close of 1891 1,001 miles of mains, 8,105 hydrants, and 697 meters.

In discussing the future water supply of the city a plan is outlined for a gravity supply from the Perkiomen and Tohickon creeks and another one for increasing the present supply by building dams on tributaries of the Schuylkill and constructing an aqueduct from Norristown to pumping stations in the city. The latter scheme is the one submitted by the Reading R. R. Co. and discussed editorially in our issue of Oct. 31, 1891. Two maps are presented in the report to illustrate this scheme.

In addition Mr. C. C. Vermeule, C. E., has reports on a proposed system of water supply from southern New Jersey. A map accompanies this.

In connection with the investigations for a new supply, Mr. John E. Codman, in charge of hydrographic work, continued flow observations on the Perkiomen, Neshaminy and Tohickon streams during 1891, completing eight years' continuous records. Rainfall observations, completing nine years' continuous records, were also made. The tables and diagrams giving the results of these

observations constitute a valuable addition to the data of rainfall and stream flow.

The report also contains detailed results of a large number of tests of steel boiler plates.

The last report of the Water Commissioners of New London, Conn., contains a diagram showing the variation in rainfall and in the level of Lake Konomoc from 1878 to Sept. 1, 1892. Mr. W. H. Richards is superintendent.

The average daily consumption of water in Chicago in 1891, according to the last report of the Department of Public Works, was 174,114,254 gallons, or 135 gallons per capita on an assumed population of 1,290,000 at the middle of the year. The total pumpage for the year was 63,551,705,550 gallons against an average height of 110 ft. and at a total cost of $380,692. The average cost of pumping 1,000,000 against 100 ft. head was $5.17, or $2.51 for fuel only. There were used 8,680 tons of anthracite coal costing $5.15 per ton; 43,905 tons of bituminous coal ranging from $2.75 to $3.42 and averaging $2.90 per ton; and 274,799 gallons of fuel oil at 1.2 cts. per gallon.

During the year 1891 there were laid 131 miles of water mains ranging from 4 to 48 ins. in diameter, and bringing the total length of water mains up to 1,347 miles, against 2,334 miles of streets in the city. Mr. J. Frank Aldrich is Commissioner of Public Works, and Mr. L. H. Clarke is City Engineer. Mr. Bernhard Feind, M. Am. Soc. C. E., who recently resigned as First Assistant City Engineer, was in charge of the water-works during the year.

A car designed to carry 124 tons on 32 wheels, says Pittsburg dispatches, is being built at the Altoona shops of the Pennsylvania Railway, to carry heavy cannon to the World's Fair. This car will exceed in carrying capacity the one illustrated in Engineering News of April 30, 1887, and intended for carrying 92 tons of Gruson armor plate. The German car weighed 58 German tons, and was 60.4 ft. long. It carried its load on 24 wheels, or 27,562 lbs. per axle. The weight and length of the Altoona car are not given; but the load will figure up 23,710 lbs. per axle.

Communication between railway cars of the European pattern, having separate compartments, was the subject of a paper read at the recent International Railway Congress at St. Petersburg, by Mr. Harry Pollitt, of the Manchester, Sheffield & Lincolnshire Ry., of England, who has devoted much time to a personal examination of the various appliances used upon British and continental railways. Mr. Pollitt condemns the cord system adopted on most of the railways in the United Kingdom as utterly inadequate. To the various electrical systems he raises the objection that they are delicate and uncertain. The original electric system of Walker, as modified by Leonard, has been in use on the Southeastern Railway for over a quarter of a century, and Mr. Pollitt admits that it has worked fairly well, but, in view of the delicate character of the apparatus, with its numerous contacts and surfaces so seldom used, the difficult question of effecting coupling, the exposure of the train to dust, rough treatment, weather influences, etc., the liability of the train being divided or added to en route, he does not recommend it for general acceptance. His alternative is a pneumatic system, which is in experimental operation on the Manchester, Sheffield & Lincolnshire Railway. The central idea of this system is the application of the means already provided in connection with the vacuum continuous brake to effect the desired communication, each car being fitted with a small air admission valve, which is connected with the continuous brake pipe. When this valve is opened it admits sufficient air to the brake pipe to reduce the vacuum from 20 to 10 ins. of mercury. This reduction of vacuum is indicated by the gages placed on the engine and in each brake or conductor's car, and is equivalent to the application of the brake throughout the train to the extent of about half its power. When the engineman finds that a communication has been made he can stop at once, or if the train be in a tunnel or in some other inconvenient or perhaps dangerous place, he can, by applying his brake ejector, exhaust from the brake pipe the same amount of air as is admitted through the communication valve, and thus practically release the brake and keep it off long enough to enable him to run on to a place of safety. The same act which opens the communication valve throws out a signal on each side of the train, so that even before a stoppage has been effected the conductor can identify the car from which the alarm was given. The position of the handle of the communicator indicates the particular compartment. This is really not a communication, but merely a means of alarm for use in emergency. It was described in our issue of Dec. 6, 1890.

A direct line of railway from Manchester to Newcastle, England, a distance of about 110 miles, is projected, and a preliminary survey has been made. No special engineering difficulties will be encountered, and the heaviest grade will be 1%. Several cities along the route are favorably disposed toward the scheme, the object of which is to give a more direct route than any now existing between the ports of Newcastle and Sunderland, and the great manufacturing district of which Manchester is the center. It is also proposed to eventually extend the line to Glasgow, the estimated cost of the whole line from Manchester to Glasgow, 220 miles, being about $40,000,000 to $50,000,000. The cost is estimated at about $175,000 per mile. The saving in distance between Manchester and Newcastle would be from 23 to 24 miles, and about 45 miles between Newcastle and Glasgow. These are the least estimates, the actual distance saved may be even greater. The terminus in Manchester will be absolutely independent, but the promotors are confident that, once the bill is passed, there will be no difficulty in getting connections with other lines through to London. No existing railway company, it is stated, is directly supporting the scheme. The principal question is whether the traffic is sufficient to warrant the expense of a direct trunk line.

ELEMENTS OF WEATHER IN THE UNITED STATES OF MOST INTEREST TO ENGINEERS FOR THE MONTH OF SEPTEMBER, 1892.

[Furnished to Engineering News by the Department of Agriculture.]

	Station.	Temperature, (Deg. Fahr.)				Wind.			Precipitation—(Rain and melted snow)—inches.		
						Velocity in miles per hour.		Direction at time of max. velocity.			
		Average	Max.	Min.	Range.	Average	Max.		Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	56.0	78	39	48	8.0	33	W	1.74	0.81	8
	Portland, Me.	59.2	76	42	34	8.0	30	S	2.89	1.57	7
	New York City	66.0	83	51	25	8.8	36	SE	0.87	0.63	4
	Pittsburg, Pa.	65.5	86	46	40	6.1	38	NW	2.04	0.60	9
	Chicago, Ill.	63.9	88	46	42	15.4	40	SW	1.34	0.82	10
	Omaha, Neb	68.2	96	42	54	6.8	24	S	1.63	0.76	7
	St. Paul, Minn.	62.6	86	42	44	7.1	24	NW	1.72	1.12	5
	Duluth, Minn.	59.4	85	44	41	6.6	25	NW	0.32	0.14	5
	Bismarck, N. Dak.	60.2	94	36	58	8.5	33	NE	0.66	0.37	7
	Average	62.3	85.8	42.1	42.9	8.4	31.4		1.37	0.76	7
Southern Cities.	Washington City	66.1	88	48	40	5.4	36	NW	3.55	1.53	8
	Louisville, Ky.	69.4	89	47	42	4.6	26	W	2.43	2.22	4
	St. Louis, Mo.	70.3	90	48	42	8.3	25	NW	1.59	0.86	6
	Savannah, Ga.	75.0	90	59	31	8.0	28	E	10.95	3.18	15
	Leavenworth, Kan.	69.6	91	42	49	7.5	28	SW	1.23	0.75	4
	Jacksonville, Fla.	76.8	92	66	26	7.2	31	SW	14.04	2.30	21
	Chattanooga, Tenn.	69.6	87	49	38	3.4	19	W	5.42	2.00	6
	New Orleans, La.	76.6	89	64	25	9.1	30	NE	6.33	1.23	12
	Memphis, Tenn.	72.0	90	52	38	5.1	32	SW	0.93	0.48	5
	Palestine, Tex.	75.2	92	57	35	4.7	18	N	0.98	0.98	2
	Average	72.1	89.8	53.2	36.6	6.3	27.3		4.75	1.55	8
Western Cities.	Helena, Mont.	60.8	89	34	55	6.9	35	SW	0.26	0.14	5
	Port Angeles, Wash.	54.0	73	38	35	4.1	30	SW	1.45	0.59	12
	San Francisco, Cal.	60.2	88	51	37	9.2	30	W	0.02	0.02	1
	Salt Lake City, Utah.	69.6	99	48	42	6.0	36	SW	0.12	0.05	4
	Denver, Colo.	66.0	92	36	56	6.4	36	NW	Trace	Trace	0
	Yuma, Ariz.	87.2	111	60	40	4.6	12	SW	0.04	0.04	1
	Santa Fé, N. Mex.	61.8	81	44	37	6.5	31	SE	Trace	Trace	0
	Average	65.1	89.1	44.4	43.1	6.24	34.3		0.57	0.12	2

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

SANDUSKY & COLUMBUS SHORT LINE.—The extension of this line south from Bellevue to Sandusky, O., has been practically completed as far as Lewis Center, about 16 miles north of the latter city.

CHICAGO & SOUTHEASTERN.—It is announced that work will soon begin on an extension of this railway from Waveland Junction to Champaign, Ill.

PORTLAND & RUMFORD FALLS.—Three routes have been surveyed for the branch to Mechanic Falls, Me., previously mentioned, and the lines are now being studied for final decision. One of these routes is 9 miles long and the other two about 11½ miles long each.

UNADILLA VALLEY.—The contractor for this 20-mile line from Bridgewater to New Berlin, N. Y., is Geo. M. Rusling, of 137 Broadway, New York City.

BANGOR & AROOSTOOK.—At the annual meeting of this company recently held, it was stated that over one-half of the grading between Brownville and Houlton, Me., is expected to be completed this autumn. It is also announced that work has been begun from Houlton north toward Presque Isle, Me.

WABASH R. R., DETROIT & CHICAGO EXTENSION.—This will be the name of the extension of the Wabash R. R. from Montpelier, O., to Hammond, Ind., 153 miles, now under construction. It is now stated that nearly 75 miles of track have now been laid and that the grading is entirely completed except in a few places.

OHIO SOUTHERN.—A press dispatch from Lima, O., says: "H. T. Douglas, Chief Engineer of the Ohio Southern R. R., arrived here Oct. 8 with a corps of assistants who have completed the survey of the extension of the line from Springfield to Lima, a distance of 61 miles. The route is almost a perfect air line. Mr. Douglas was joined here by H. T. Mathers, general attorney of the company. They stated that the road would be completed here by April 1."

Projects and Surveys.

LACKAWANNA, LAKE ERIE & HONESDALE.—This company, whose incorporation was noted in our last issue, has completed its organization by the election of the following officers. Treas., Chas. DuPont Breck, of Scranton, Pa.; Secy., T. J. Ham, and Pres., W. H. Dimmick. The company proposes to build a railway from Honesdale, Pa., to a connection with the Delaware, Lackawanna & Western Ry. between Elmhurst and Moscow. Surveys for the line will begin at once under the direction of E. L. Jenks, of Scranton, Pa.

CHESTER, UNIONVILLE & WESTERN.—Surveys are in progress on this railway from Unionville, Pa., to West Chester, Pa., under the direction of J. C. Sharpless.

TAKOMA, BURNT MILLS & SANDY SPRINGS.—This company is to bechartered in Maryland to build a railway from Takoma via Burnt Mills to Sandy Springs, Md. The officers of the company are: Pres., Chas. G. Stone, Brightwood, D. C.; Vice-Pres., Francis Thomas; Secy., Daniel O'Driscoll, and Treas., W. E. Mannakee.

Southern.—Existing Roads.

JELLICO & BIRD EYE.—Ch. Engr., W. C. Crozer, of Knoxville, Tenn., writes us that the surveys are completed and that construction is in progress on this 7½-mile line from Jellico to Bird Eye, Tenn. The line is being built by the Jellico & Bird Eye Coal Co., and its principal business will be in coal and lumber. There is one iron bridge 152½ ft. in length. The contractor for the grading, masonry and cross-ties is the Chattanooga Construction Co., of Chattanooga, Tenn. It is intended to begin tracklaying about Dec. 1, 1892, and to have the line completed by Jan. 1, 1893. The President of the company is E. T. Halsey, Louisville, Ky.

ARCADIA, GULF COAST & LAKELAND.—It is announced that this company has let new contracts for constructing its line beyond Lakeland, Fla. Ch. Engr., K. B. Harvey, Punta Gorda, Fla.

MONTGOMERY, HAYNEVILLE & CAMDEN.—Pres. Sol. D. Bloch, Camden, Ala., writes us that the contracts have been let for grading 10 miles of this railway and that work is now in progress. The line as surveyed is to run from Camden, Ala., via Oak Hill, Furman, Farmersville and Hayneville, to Montgomery, Ala., 73 miles. The grades vary from 1% to 1¼%. Ch. Engr., C. P. Rogers, Camden, Ala.

GEORGIA, CAROLINA & NORTHERN.—An official of this company says that the 8½-mile belt line at Atlanta, Ga., is nearly completed.

CHESAPEAKE & OHIO.—Surveys are in progress for a branch up Twenty-Mile Creek in West Virginia which, it is stated, will be constructed soon.

GLENDON & GULF MINING & MFG. CO.—It is stated that the railway, which this company has under construction from Gulf, N. C., to Glenn's Mills, 10 miles, will be extended 15 miles further into Randolph Co.

WILMINGTON, ONSLOW & EAST CAROLINA.—Work on the extension from Jacksonville to Newbern, N. C., is making rapid progress. About 25 miles have now been graded.

PADUCAH, TENNESSEE & ALABAMA.—The extension of this railway from Hollow Rock to Lexington, Tenn., 20 miles, where it will connect with the Tennessee Midland R. R., has been completed.

KANAWHA & MICHIGAN.—The grading on the extension from Malden, W. Va., to a connection with the Gauley River branch of the Chesapeake & Ohio Ry., is expected to be completed in about 30 days.

BIRMINGHAM, SHEFFIELD & TENNESSEE RIVER.—New surveys are being made for the proposed extension to Birmingham, Ala., and, according to the local papers, work will be commenced soon.

Projects and Surveys.

BLUE MT. MINERAL.—The "Manufacturers' Record" says: "A movement is on foot to build and equip the Blue Mountain Mineral R. R. from Anniston, Ala., to mineral lands, about seven miles distant."

ALABAMA WESTERN.—Chartered in Alabama to build a railway from Clanton, Ala., to a point near Cincinnati junction. Among the incorporators are: Geo. H. Robertson, of Maplesville, Ala., and Lester C. Smith, of Montgomery, Ala.

SHAFER-NICHOLS-WATKINS CO.—This company has been chartered in Kentucky to build railways, bridges, etc.

MOBILE, JACKSON & KANSAS CITY.—The report is again in circulation that the necessary capital for building this railway from Mobile, Ala., to Jackson, Miss., has been secured. Pres., H. Austill, Mobile, Ala.

Northwest.—Existing Roads.

CHICAGO, ROCK ISLAND & PACIFIC.—Robert W. Day, Div. Engr., Topeka, Kan., writes us that 1,000 men are at work on the Jansen extension, from Lincoln to Jansen, Neb., 53 miles. About one-third of the grading and 10% of the bridging have been finished, and tracklaying will be begun soon. The work is mostly quite heavy; maximum grade 1%, and maximum curve 3° The contractors are: J. A. Ware & Son, McCormick Bros., and Templeton & Morrow.

WABASH, CHESTER & WESTERN.—The line from Tamaroa, to Mt. Vernon, Ill., 22.3 miles long, has been completed and will soon be opened for business.

PORT ARTHUR, DULUTH & WESTERN.—Work is now in progress on the last five miles of this line, from Port Arthur, Ont., to Gunflint Lake, on the international boundary, and, with the exception of the branch to the mines of the Gunflint Iron Co., 6 miles, which will take about two weeks longer, it is expected to have the entire line completed by Nov. 1.

BURLINGTON, CEDAR RAPIDS & NORTHERN.—The contractors, Kimball & McNamara, are making rapid progress on the extension west from Forest City to Armstrong, Ia. It is expected to have the line completed by Dec. 1.

Projects and Surveys.

PHILLIPS & LA CROSSE.—The contracts for this railway from Phillips to Keenan, Wis., about 15 miles, are reported to have been let. It is stated that a force of 200 men will be put at work at once, and the line completed by the end of the year.

CHICAGO & SOUTHERN.—Chartered in Illinois to build a railway from Chicago to a point near Paris, Edgar Co., Ill. Among the incorporators are Francis Hinckley, of Chicago, Ill., and Frank H. Jones, Springfield, Ill.

Southwest.—Existing Roads.

NORTH GALVESTON, HOUSTON & KANSAS CITY.—It is announced that the grading on this line from Virginia Point to North Galveston, Tex., will be completed by Dec. 10. Tracklaying will begin as soon as the rails arrive.

SOUTHERN PACIFIC.—The grading for the branch to Abbeville, La., 16¼ miles, has been completed, and about four miles of track have been laid.

KANSAS CITY, ELDORADO & SOUTHERN.—This company has notified the Secretary of the State of Missouri of its intention to build extensions from Rich Hill, Mo., to a connection with the Kansas City, Nevada & Ft. Smith R. R., near the south side of the Marie des Cygnes River, 16 miles, and from West Eldorado, Mo., to Aurora, Mo., 79 miles.

MISSOURI, KANSAS & TEXAS.—The grading on the Houston Extension has been completed nearly to Sealey, Tex., 27 miles east, and surveys are in progress from Sealey, east to Houston.

LA PORTE, HOUSTON & NORTHERN.—This company will purchase 17 miles of steel rails and equipment for its line. The line now under construction runs from La Porte to Harrisburg, Tex., 16.7 miles, and about two-thirds of the grading has been completed. Gen. Man., T. A. Lee, La Porte, Tex.

Projects and Surveys.

ST. LOUIS, COLLINSVILLE & CARONDELET BELT.—A dispatch to the St. Louis, Mo., "Globe-Democrat," says: "A mortgage for $1,500,000 of bonds from the St. Louis, Collinsville & Carondelet Belt Ry. Co., to the New York Security & Trust Co., has been filed for record in Madison and St. Clair counties, Ill. The purpose is to raise money for the completion of the railway. It is the intention of the company to construct a double track railway from the Merchants' Bridge, via Collinsville, in Madison County, and O'Fallon and Belleville, in St. Clair County, to East Carondelet, and it is understood that construction work will begin at once. This line will connect with all of the railways entering St. Louis from the east side of the Mississippi River, and with those on the west side of the river through the Merchants' Terminal."

TEXAS & SABINE VALLEY.—Chartered in Texas to build a railway from Carthage, Panola Co., to Center, Shelby Co. Among the incorporators are: W. F. Hubbard and F. M. Larcher, of New York City.

GULF, NEWPORT & NORTHERN.—This company, which was reported to have put 20 miles of its proposed line under contract, in our last issue, proposes to build from Pass Caballo to aSn Antonio, Tex., according to later reports. Among those interested are Thos. M. O'Conner, Wm. Davis and Robt. C. Sadler, of Victoria, Tex.

GALVESTON, BEAUMONT & ALEXANDRIA.—In a recent newspaper interview, Vice-Pres. Geo. S aly is reported as saying that a preliminary survey is now in progress for this projected railway. The line starting from Bolivar point will run along the ridge of Bolivar peninsula to the western boundary of Jefferson, Tex., and thence it will be almost an air line to Beaumont, Tex., from which city the road will deflect northeast, penetrating the pineries of Jasper and Newton counties, Tex., crossing the Sabine River at or n ar Belgrade, thence through the northwestern and southeastern portions of Calcasieu and Vernon parishes, La., and thence through Rapides parish to Alexandria, La., connecting there with the Illinois Central railway system.

Rocky Mt. and Pacific.—Existing Roads.

BURLINGTON & MISSOURI RIVER.—A correspondent writes us that a force of 600 teams are now at work on the extension of the Grand Isle & Northern Wyoming R. R., from Gillette to Sheridan, and the Tongue River, Wyo., 110 miles. About 73 miles of track are now laid, and it is expected to have the line completed to Sheridan by Dec. 1. The grades on this extension vary from 1% to 1½%, and the curves are generally 2°, with a maximum of 4°. The contractors are Kilpatrick Bros. & Collins, of Beatrice, Neb.

NORTHERN PACIFIC.—This company will begin work at once improving its Spokane & Palouse branch by reducing grades and straightening curves. About $150,000 will be expended in this work.

BUTTE, ANACONDA & PACIFIC.—The force of men at work between Butte and Anaconda, Mont., is being rapidly increased, and additional men and teams are wanted. Contracts for cross-ties are being let.

GREAT NORTHERN.—Only about 90 miles more of track remain to be laid to complete the Pacific extension to the coast, with the exception of the long tunnel at the summit of the Cascade Mts., and the steel bridge over the Columbia River. While the tunnel and bridge are being built, the company will use a switchback at the summit and transfer boats at the river. Tracklaying from the east is now completed to the Columbia River, and grading is in rapid progress between that point and the mountains. On the western side of the mountains tracklaying has been delayed by the lack of rails.

Projects and Surveys.

CANADA WESTERN.—A press dispatch says: "The British Pacific Construction Co., which is to construct this road, is now a thoroughly organized and regularly incorporated company. The capital stock of this company is $5,000,000, divided into 50,000 shares of $100 each. The company is incorporated, primarily, for the purpose of laying out, building and equipping the Canada Western road, from Victoria, B. C., or Wellington, to Seymour Narrows, Ft. Rupert and the north end of Vancouver Island, for the island division, and from Butte Inlet on the mainland through the Chilcotin, Caribou and Peace River countries to the Yellow Head Pass, for the mainland division. By virtue of a contract entered into by the Canada Western by its provincial directors, the railway company will transfer to Frank Bakeman, as trustee for the construction company, all its land grants, subsidies and premises, on condition that the construction company builds and equips the road according to the terms of the company's charter. The route of the proposed railway has been surveyed, and its feasibility in point of construction for all purposes of railway traffic has been fully established. Complete instrumental surveys, with maps, plans and profiles of the line from Butte Inlet to Yellow Head Pass, 546 miles, have been made by the Dominion Government, and are available. The articles of the construction company are very comprehensive, and provide for all manner of rights useful in the development of the country to be reached by the railway."

TRINIDAD, SAN LUIS VALLEY & PACIFIC.—The surveys have been completed for this proposed line from Trinidad, Colo., to Costillo Pass, N. Mex., 60 miles. The work will be very heavy. The company has not yet been organized. Ch. Engr., J. R. DeRemer, Denver, Colo.

Foreign.

MEXICAN NORTHERN PACIFIC.—Work has been resumed on the partly graded section of this railway, from Deming, N. Mex., south to the Mexican line. It is stated that it will take about 30 days to complete this section, after which work will be continued on into Mexico. The contractors for the entire line, which is to run from Deming, N. Mex., to Guerreo, Mex., and then branch east to Chihuahua and west to Topolobampe, are Hass, Townsend & Co., of Chicago, Ill. Engr. of Cons., A. T. Wilcox, Deming, N. Mex.

BRITISH MEXICAN.—The grading on the first 30 miles of this road, which is to be run from Jiminez, on the Mexican Central Ry., to the great mining camp of Sierra Mojada, has been completed, and the purchase closed for all the rails to be used on the line. J. F. Dickey, the Resident Director of the road in Mexico, is now in England on business connected with the new enterprise.

ELECTRIC RAILWAYS.

BUFFALO, N. Y.—The Buffalo & Williamsville electric railway contract has been let to J. D. Murray, of New York, for $49,000, not including the power building, engine and boilers. About half the road is graded and work is progressing rapidly. The road will be about 4½ miles long and will be a continuation of the Main St. Electric line. The John T. Noye Mfg. Co., of Buffalo, St. electric line. The John T. Noye Mfg. Co., of Buffalo, gine for the plant, and the electrical generator and motors will be of the Thomson-Houston type. The road complete and equipped with two motor cars and two trail cars will cost $62,000. Voorhees & Witmer are the engineers in charge.

WASHINGTON, D. C.—The trolley system being forbidden, the Rock Creek line will use a conduit system on its city extension. The Washington & Georgetown Ry. has adopted the cable system, and has 10.26 miles of double and .55 miles of single track of this construction. The Metropolitan line has selected the storage battery, and has spent much time and money in perfecting this system. The change from horses to a mechanical motor must be made upon this line before July 22, 1893. When in practical operation with its 8.36 miles of double and 2.35 of single track, this will be an extensive storage battery system. On the G St. extension of the Eckington suburban road, into the city, 1.17 miles in length, the storage battery system is in successful use. Before July 1, 1893, the Eckington road must change the motive power of the mile of its line lying within the city limits, that is at present operated by the trolley, to some form which will not require the overhead construction. It will select either the storage battery, which it uses on its present G St. extension, or it will operate with an underground electric conduit over all that part of its line which lies within the city, including an East Washington extension, authorized by law, but not yet constructed, and including the section over which the storage battery cars now run. The Columbia Ry., with 2.81 miles of double track, is also soon to adopt a mechanical motor, with either the storage battery or an underground electric conduit. Its choice will probably be determined by the degree of success of the Metropolitan storage battery when in practical operation. The Belt line, the third of the local street railways with 0.09 miles of double track, and 1.13 miles of single track, proposes to adopt soon an improved motive power, and has been looking over compressed air and carbonic gas motors.

TAMPA, FLA.—The Consumers' Electric Light & Street Ry. Co., has been incorporated by E. S. Douglass, A. C. Wuerpel, W. B. Henderson, and has purchased the equipment of the Suburban Ry. Co., with other property. The Westinghouse system will be used.

CHICAGO, ILL.—The Chicago & St. Louis Ry. Co., whose line was described in our issue of Feb. 20, has placed its stock on the market, and applications will be received by the Atlas National Bank and the Bank of Commerce, from Nov. 1 to Nov. 7. Gen. Man., Wellington Adams.

ST. PAUL, MINN.—The Board of Aldermen has ordered the street railway company to build over a mile of extension of the electric line.

LEAVENWORTH, KAN.—The Leavenworth Electric Street Ry. Co. has given a $300,000 mortgage to the American Loan & Trust Company, for the purpose of converting the line to an electric road, and extending it to Lansing. The company is now using steam motors and its line terminates at the Soldiers' Home.

PORTLAND, ORE.—For the following particulars of the Barnes Heights & Cornell Mountain Ry. we are indebted to Mr. N. E. Graves, Gen. Supt. and Engr. The contractors were as follows: For construction to the bottom of rail, O. M. Pihl & Co.; for rails, joints and spikes, Pennsylvania Steel Co.; for electrical equipment. Northwestern Thomson-Houston Co., Portland, Ore.; for steam plant, pumps, etc., Russell & Co., Massilon, O.; for rolling stock, J. G. Brill Co., Philadelphia, Pa. The grading, bridge work and tracklaying are now complete, and the overhead wire construction is well under way. The car barn and power house are complete, including engines, boilers and dynamos, and it is expected to make the first trip in November.

SACRAMENTO, CAL.—The city has granted a franchise to H. P. Livermore and Albert Gallatin, to construct and operate another extensive electric car system, which, with the one now running, will give Sacramento a very complete street car service.

LONDON, ONT.—The amended proposal of the new electric street railway company has been accepted, and the old street railway company has 30 days in which to accept the bargain. By the arrangement with the new company the work of building the track must be begun between Nov. 15, 1892, and March 15, 1893. Seven miles of the railway must be completed, and the electric cars running thereon within two years. At the end of 20 years the city may, after six months' notice, assume the ownership of the railway on payment of its value, to be determined by arbitration. The company will pay yearly to the city $100 per mile of single track and $200 per annum per mile of double track, if the gross receipts of the railway are $80,000 a year. The company will also pay on all gross receipts under $100,000, 5%; between $100,000 and $125,000, 5½%; between $125,000 and $150,000, 6%; between $150,000 and $175,000, 6½%; between $175,000 and $200,000, 7%; over $200,000, 8%.

ELEVATED RAILWAYS.

BALTIMORE, MD.—Mr. James L. McLane has been elected President of the Lake Roland Elevated Ry. Co., to succeed Mr. J. M. Jarvis, of Kansas City, resigned. Mr. McLane was formerly President of the North Baltimore Ry. Co. It is said the construction of the road is going ahead satisfactorily. The foundations for the structure on North St. have been commenced, and the only thing which will now delay the construction, it is said, will be failure to secure the needed material.

HORSE AND MOTOR RAILWAYS.

PLYMOUTH, MASS.—At the annual meeting of the Plymouth & Kingston Street Ry. Co. a dividend of 7% was declared. The road carried 504,000 people during the year. Pres., John H. Cunningham, of Chelsea.

NEW YORK, N. Y.—Mayor Grant has signed the amended resolution permitting the Metropolitan Traction Co. to extend its route from 64th St. to 110th St., through Columbus Ave. This is the resolution which the Aldermen amended at a special session on Oct. 10, forbidding the use of the trolley. It is understood that the control of the stock of the 42d St. & Grand St. Ferry Ry. has been secured in the interest of the Metropolitan Traction Co.

WASHINGTON, D. C.—The Suburban Ry. Co. has instructed Mr. D. J. Howell, the engineer, to prepare specifications for bids for the Brookland and Langdon branches, and, if possible, have these branches completed by December.—The Belt Line proposes to adopt compressed air or carbonic gas motors.

RIVER VIEW, ALA.—A steam motor or dummy line is to be established between River View, Ala., and West Point, Ga. The West Point Mfg. Co. is interested.

HIGHWAYS.

NEW YORK.—At a meeting of the Kings County Board of Supervisors, at Brooklyn, Mr. French presented the revised plans and specifications for macadamizing St. Johnland roads, and extending the sewers there, and a resolution was adopted by the Supervisors approving the plans and specifications, and directing the County Farm Committee to advertise for proposals for the work to be opened at a meeting of the Board.

MARYLAND.—Road Supervisor Peter Link, of Baltimore Co., is putting a large amount of crushed stone on those roads in the first district that have not heretofore been macadamized. Three stone crushers in the district are owned by private individuals. The crushed stone is furnished on the roads at $1.75 to $2 a perch, according to the hauling distance. Crushed stone is now being shipped from the county stone crusher, at McDonogh, on the Western Maryland Ry., to Pikesville, Arlington, Howardville, Mount Washington and Ruxton. Stone is also being furnished for roads in the second district near the crusher. It is the intention of the commissioners to finish macadamizing the Joppa road to Sherwood this fall of the coming winter.

CALIFORNIA.—The town of Sisson proposes to build a system of good roads to open up Trinity Co.—The Supervisors of Contra Costa Co., at Martines, propose to make an appropriation for the road to Contra Costa. A plan is before them by which the road can be completed at a grade not exceeding 5%. To make the road a thoroughly practical and useful one, however, it is stated, that an expensive bridge will have to be built, and it is the cost of the bridge that has deterred the supervisors from taking definite action before now. The tunnel proposed is too expensive to be entertained,

although part of the old Kennedy road will be used. The larger part of the money for the road has been subscribed by private individuals, and $6,000 is asked from the Supervisors to complete it. The Board of Trade has decided by personal inspection that the road if constructed will prove a great benefit to both counties, and is using its influence as a body to secure the appropriation.

WATER-WORKS.

New England.

BRYANT'S POND, ME.—Engr. Thos. H. Madigan, Berlin Falls, N. H., is making surveys and estimates for gravity works.

MELROSE, MASS.—The Water Board has been authorized to expend $1,000 in investigations for an additional supply.

PROVINCETOWN, MASS.—It is reported that works, including a pumping station and stand-pipe, will at once be built under the direction of the Water Commissioners. Engr., Louis Hawes, Boston.

Middle.

CHESTER, N. Y.—The contract for works has been awarded to Francis Leonard, Norwalk, Conn., for $42,000, less the cost of pipe, which is to be furnished by the city at $26.50 per ton. There will be a dam.

DAVENPORT, N. Y.—It is reported that the water supply will be from Nigger Brook.

FORT EDWARD, N. Y.—S. E. Babcock, Little Falls, has been engaged to make the final survey and estimate for village works.

JERSEY CITY, N. J.—Bids for building a reservoir on Snake Hill are wanted by the County Board of Chosen Freeholders until Nov. 3; also for 6 and 8-in. cast iron pipe and specials.

JERSEY CITY, N. Y.—Chf. Engr. W. W. Ruggles has prepared specifications for a new water supply, to be delivered by gravity, at Belleville. Bids will state price per million gallons. The minimum supply will be 22,000,000 daily, and 35,000,000 gallons may be called for. Large storage reservoirs must be built.

LINESVILLE, PA.—Works are talked of.

NEW WILMINGTON, PA.—Bids for constructing works will be received until Nov. 2. H. G. McVey, Secy. New Wilmington Water Co.; T. A. Gilkey, Engr., New Castle.

SHENANDOAH, PA.—The contract for the dam, reservoir and pipe line for the borough works has been awarded to M. P. Quinn and T. F. Kerns, Shenandoah, for $78,700. Pumps will be furnished by other contractors for $14,500.

WILLIAMSPORT, PA.—The Water Board has authorized the company to place a 5,000,000-gallon pumping engine. It will be a compound condensing duplex.

Southern.

WEST POINT, ALA.—Works estimated to cost $20,000 are projected.

NEW ORLEANS, LA.—Bids for furnishing and laying 9½ miles of 6-in. pipe are wanted by the Rosetta Gravel & Improvement Co.

NASHVILLE, TENN.—Bids for $100,000 4½% water bonds will be received until Nov. 2 by J. T. Bell, Recorder.

PULASKI, TENN.—It is reported that J. E. Thompson, B. L. Ridley and others have applied for the incorporation of a company.

COVINGTON, KY.—The Suburban Water Co. proposes to supply Mildale, Rosedale and South Covington.

North Central.

MARTIN'S FERRY, O.—Bids are wanted until Nov. 10 for a 2,000,000-gallon vertical, duplex, compound, non-condensing, pumping engine, to work against a 300-ft. hydrostatic head through about 4,000 ft. of 12-in. pipe; also for boilers. Address Trustees, Water-Works.

COLUMBIA CITY, IND.—It is reported that works are wanted.

LA GRANCE, IND.—A vote of 279 to 70 for works has been cast.

ROANN, IND.—It is reported that this place will build works.

BELLEVILLE, ILL.—The Belleville Water Co. has been incorporated to operate under the franchise recently granted to A. M. Farnum, who with Joseph Fuess, Geo. W. Detharding and Edward Abend, are incorporators. Capital stock, $350,000. The City Water Co., it is said, is now in the hands of its bondholders and may consolidate with the new company.

GRANITE CITY, ILL.—The Granite City & Madison Water Co. has been incorporated by Wm. F., F. G. and Henry Niedringhaus; $250,000.

Northwestern.

OTTUMWA, IA.—The Ottumwa Artesian Well Co. has been incorporated to supply the city; $100,000. The Iowa Water Co. owns works here.

SENECA, KAN.—It is reported that the "Burnes people, of St. Joseph," will own and operate works here.

BRIDGEWATER, S. DAK.—A flowing well and works are talked of.

HOT SPRINGS, S. DAK.—Works may be built by the Hot Springs Improvement Co. J. B. Dickover, Mayor.

Southwestern.

SEDALIA, MO.—The Sedalia Water-Works Co. has increased its capital stock from $200,000 to $250,000.

EL PASO, TEX.—The Council has instructed Cy. Engr. Campbell to prepare plans and specifications for works with a supply from the Noria Mess. A company now supplies the city. Various applicants for a franchise have recently been before the Council.

KINGFISHER, OKLA.—A vote of 225 to 32 has been cast in favor of works.

Pacific.

BALLARD, WASH.—Plans for water and sewer systems are being made. Water-works are estimated to cost $60,000. An artesian supply is talked of, and C. Monjean, Cincinnati, O., has made a proposition to sink test wells.

COLTON, WASH.—P. B. Dyer & Co., Seattle, have the contract for works.

GARFIELD, WASH.—A vote of 86 to 7 has been cast in favor of $10,000 of bonds for works.

MILTON, ORE.—Works are under construction.

OAKDALE, ORE.—J. G. Kelly has the contract for works here.

Canada.

TORONTO, ONT.—The Water-Works Committee has recommended that an 8-ft. steel pipe be substituted for the 6-ft. pipe which now forms a part of the intake pipe. Estimated cost, $76,740.

IRRIGATION.

NEW COMPANIES.—The Pawnee Pass Reservoir & Irrigation Co., Sterling, Colo.; $1,000,000; Minos C. King, Henry C. Palmer, and others. Midland Reservoir Co., Denver, Colo.; $100,000. Mulberry Creek & Arkansas River Irrigation Co., Ford, Kan.; $10,000; J. M. Imel, Ford; S. P Zeakel, Kansas City, Mo., and others.

SEWERS.

PORTLAND, ME.—Plans have been prepared for the extension of the Deering sewer system. The estimated cost is about $40,000.

FRAMINGHAM, MASS.—At a special meeting Oct. 18, the town voted to extend the public sewer in three streets.

BOSTON, MASS.—Bids were opened Oct. 22 for section 28 of the metropolitan sewerage system, in Cambridge. The length of the section is about 6,500 ft.; average depth, 18.5 ft.; external diameter, 6.3 ft.; cubic yards of brick and other masonry, 3,000. The bids were as follows: Charles G. Crailb, $94,860; Millon & McKenzie, $94,070; Chas. Linnehan, $84,427; H. P. Nawn, $83,040; John Sheehan, $82,695; Metropolitan Construction Co., $81,559; Cashmann & Judd, $79,000; Malone & Talent, $78, 722; Jones & Meehan, $78,190; National Construction Co., $74,000; Christopher McBride, $70,470; John L. Reardon, $70,140.

MELROSE, MASS.—The town has appropriated $1,500 for plans for a system of sewerage in conjunction with the metropolitan system, of Boston.

PLYMOUTH, MASS.—A committee of five including Chas. B. Stoddard and Jas. B. Collingwood, has been appointed to consider the subject of a sewerage system and report methods of sewage disposal for the different parts of the town, and cost of the same.

SOUTHBRIDGE, MASS.—At a special meeting Oct. 17, the town voted to borrow $11,000 for sewer construction.

WATERTOWN, MASS.—We are informed by A. H. Hartwell that at a special meeting Oct. 18 the town voted unanimously to make sewer extensions estimated to cost $22,747, and appropriated $25,000 to pay for the same. It was left with the Selectmen to arrange for doing the work without delay.

WINTHROP, MASS.—We are informed by H. T. Whitman, Engr., that the sewer contract has been awarded to Thos. Floyd, at about $9,800.

PROVIDENCE, R. I.—An additional $200,000 has been appropriated for the construction of lateral sewers.

WINDSOR LOCKS, CONN.—A committee has been appointed to secure a charter for a sewerage system. J. R. Montgomery is a member.

CHATAUQUA, N. Y.—Bids are asked until Nov. 30 for furnishing necessary machinery and appliances for the treatment of sewage at this place. Samuel M. Gray, Cons. Engr., Providence, R. I. See advertisement.

BUFFALO, N. Y.—The Board of Public Works will receive bids until Nov. 2 for 10 to 20-in. tile sewers in seven streets.

CARTHAGE, N. Y.—Plans and estimates for a system of sewers are being prepared by C. O. McComb, Engr., but we are informed by Mr. McComb that no definite action will be taken with regard to construction until the question has been submitted to a vote of the citizens.

GLENS FALLS, N. Y.—The Village Treasurer will receive bids until Nov. 1 for $167,000 of sewer bonds.

HAVERSTRAW, N. Y.—Sewer Commissioners have been appointed and will secure estimates for a sewer system for the village.

HORNELLSVILLE, N. Y.—The contract for the completion of the sewerage system has been awarded to Colman, Dunspaugh & Perry. The cost of the work done under the direction of the Sewer Commissioners will be assumed by the new contractors. The contract for this system was awarded about May 1 last to Miller & McDougal at $87,874, the highest bid being $141,381, and the contract prices were published in our issue of May 5. Miller & McDougal threw up the contract several weeks ago, and for a short time the work was continued under the direction of the Sewer Commissioners.

NEW YORK, N. Y.—The Commissioner of Street Improvements of Wards 23 and 24 will receive bids until Nov. 4 for sewers in Bergen Ave., 157th St., and Railroad Ave., West.

ROCHESTER, N. Y.—The field work upon the West Side sewer has been completed and the engineers are now preparing maps and profiles upon which to base estimates and prepare specifications. It is expected that these will be completed so that the work can be advertised about Jan. 1.

SYRACUSE, N. Y.—The Council has directed the Clerk to advertise for bids for several 15 and 18-in. tile sewers.

UTICA, N. Y.—Several sewer proposals have been rejected and the work will be readvertised.

WATERLOO, N. Y.—Plans for the proposed sewerage system are nearly ready to be presented to the Board of Trustees for inspection and consideration.

WHITESTONE, N. Y.—The Village Trustees have decided to petition the next legislature for authority to issue bonds for the construction of a sewerage system.

JERSEY CITY, N. J.—The Board of Street Commissioners will receive bids until Oct. 31 for 530 lin. ft. of 15-in. pipe sewer and 1,100 lin. ft. of 24-in. brick sewer. The work will include about 15,000 ft. B. M. hemlock or spruce timber flooring, 8,000 ft. B. M. sheet piling left in work, 450 cu. yds. rock excavation, etc.

ORANGE, N. J.—In our issue of Aug. 25 we noted that the Empire Construction Co., owing to unexpected difficulties encountered in the construction, had ceased work upon the main section of the sewerage system, the contract for which was awarded in June, 1891, at $239,174. After about two months spent in trying to reach a settlement, a compromise is said to have been made by which the Empire Construction Co. is to receive an advance of 33⅓% on the contract price for the brick sewers, provided the contract is fully carried out by the company, and is to receive $4,250 cash in settlement of all indefinite claims of the company against the city. This was agreed to several days ago by the Common Council, but the Mayor's signature was withheld in the hopes, it is said, that the company might be held to the terms of the original contract, or that some other way might be found whereby construction might be resumed. It is claimed that other contractors refused to continue the work at any price.

PHILLIPSBURG, N. J.—The Sewer Committee has been directed to advertise for bids until Nov. 1 for a sewer in Heckman St.

POTTSVILLE, PA.—The Council has voted to construct several additional sewers.

PHILADELPHIA, PA.—The Mayor has approved an ordinance authorizing the Department of Public Works to advertise for proposals for a main sewer in Germantown Ave. and other streets in Ward 22.

WILMERDING, PA.—The borough will receive bids until Nov. 7 for brick storm sewers as follows: 30-in., 1,000 lin. ft.; 36-in., 620 lin. ft.; 42-in., 345 lin. ft.; 9 catch basins, and 5 manholes. C. C. Cowell

FORT MONROE, VA.—We are informed by Maj. Chas. E. L. B. Davis, Engr. in Charge, that the system of sewerage now being devised for Fort Monroe will make provision for the disposal of the sewage of the entire reservation, including both the military and civilian residents. Owing to the character of the site, which is flat and lying but little above the sea level, with the buildings scattered over a wide area, the works will be quite extensive. The work will probably be done by contract.

MANCHESTER, VA.—The Sewer Committee has recommended that the City Engineer advertise for bids for a system of sewers to be built in accordance with the plans of G. E. Waring, Jr.

ATLANTA, GA.—The suburb of West End has employed E. B. Latham to design a system of sewers. There will be between 13 and 14 miles of sewers, all pipe, with manholes and flush tanks; estimated cost, $50,000. Work will probably begin by January.

CLEVELAND, O.—The construction of a sewer in Detroit St., with an outlet to the Cuyahoga River, will be readvertised. The bids recently received for the work ranged from $34,900 to $56,901.

IRONTON, O.—The estimated cost of that part of the proposed sewerage system designed by Rudolph Hering, that it is proposed to construct at once, aggregates about $113,000.

KOKOMO, IND.—The City Clerk will receive bids until Nov. 7 for a 12-in. vitrified tile sewer.

DETROIT, MICH.—The contracts for sections 1 and 2 of the Helen Ave. sewer have been awarded to Langley & Jeynes at $3.27 and $2.23 per lin. ft., respectively, and $54.75 each for manholes.

NEGAUNEE, MICH.—The contract for main sewers has been awarded to Wolf, King & Co., West Superior, Wis., at $32,542. The prices will be published next week.

ST. PAUL, MINN.—A contract has been awarded to Thos. Reilly at $12,927.

BOONE, IA.—We are informed by M. R. Laird, Engr., Des Moines, that this city is about to build 5,000 ft. of sanitary sewers to act as an intereceptor to the sewerage part of the city drainage. The sewers carry storm water, but only dry weather sewage will be discharged into this one, the storm water to be discharged by overflows into the water course.

FARGO, N. DAK.—The City Auditor will receive bids until Nov. 7 for three sewers.

KANSAS CITY, MO.—The contract for the completion of the Pryor section of the O. K. Creek sewer has been awarded to Wm. Taylor at $29,969. The bid was at the rate of $26.50 per lin. ft. The contract for a sewer in district No. 147 was awarded to Cotter, McDonald & Co., at $18,437.

RICH HILL, MO.—A system of sewerage is being agitated by the "Review."

OGDEN, UTAH.—Bids will soon be asked for sewers in several streets.

LOS ANGELES, CAL.—The City Clerk will receive bids until Nov. 14 for sections 1 to 9 of the outfall sewer. The highest bid for the $395,000 outfall sewer bonds was that of Blair & Co., New York, N. Y., who offered par, accrued interest and a premium of $9,904.

REDWOOD CITY, CAL.—The city has voted to issue bonds for $35,000 for a sewer system.

SANTA ROSA, CAL.—The Sewer Committee has been authorized to purchase 3,950 ft. of 6-in. pipe, 1,000 ft. of 8-in., together with cement, etc., required to construct proposed sewers.

CORVALLIS, ORE.—We are informed by G. W. Waggoner, Engr., that probably $40,000 will be expended for sewerage, but that no definite action has been taken by the Council and there is little probability of any construction being done this autumn. Jos. G. Kelly, Eugene, has been engaged as Engineer in Charge.

BALLARD, WASH.—Plans and estimates for a sewerage system have been made.

STREETS.

BOSTON, MASS.—The Mayor has signed ordinances providing for the widening of Water, Howard and Norfolk Sts. It is proposed to widen Washington St. for a considerable distance. The Finance Committee has been instructed to provide $20,000 for the paving of East Sixth St., between K and O Sts.; $50,000 for regrading Congress St. between A and L Sts. bridge; $30,000 for paving East Eighth St. between Old Harbor and K Sts., and $50,000 for construction of Talbot Ave. in Ward Twenty-four.

BUFFALO, N. Y.—Bids were opened Oct. 22 for paving several streets. The lowest for paving Chicago St. were P. B. McNaughton, $42,030 for Medina block sandstone, and the Buffalo Paving Co., $28,452 for Syracuse brick. For paving Douglass Alley, the only bid was that of P. B. McNaughton, $48,000 for Medina sandstone, or $35,019 for Syracuse brick.

SYRACUSE, N. Y.—The Council has directed the Clerk to advertise for bids for grading Teall Ave., and has ordered that surveys be made for other improvements. The following are the lowest bids received for paving three streets, the bid in each case including the maintenance of the pavement for five years from its completion without cost to the property owners or the city: Wm. H. Gallup, paving South Salina St. with Trinidad Lake asphalt, $54,114; D. S. Howe, Delaware

St. with Trinidad Lake or Sicilian asphalt, $38,175; Callaway, Rann & Co., South Salina St. with vitrified brick, $49,649, and Delaware St. with vitrified brick, $29,798.

JERSEY CITY, N. J.—The Board of Street Commissioners will receive bids until Oct. 31 for the improvement of Brunswick St., the work to include about 5,300 sq. yds. stone paving, 5,000 cu. yds. earth filling, 1,500 cu. yds. earth excavation, new curb, new flagging, etc. Bids will be received until Nov. 7 for the improvement of 17th St., the work including 1,100 sq. yds. stone paving, 18,000 cu. yds. earth filling, 2,550 lin. ft. new curb, 10,000 sq. ft. new flagging, etc.

JENKINTOWN, PA.—Bids are asked until Oct. 31 for macadamizing all the streets of the borough. John Mayer, St. Comr.

ALEXANDRIA, VA.—Street improvement and sewer bonds for $100,000 are about to be sold.

KNOXVILLE, TENN.—We are informed by M. Nicholson, Cy. Engr., that the City Council is agitating the question of street paving, but as yet neither the time for beginning the work nor the material to be used has been decided upon.

FREMONT, O.—The Committee on Improvement will receive bids until Nov. 21 for the improvement of Morrison St.

INDIANAPOLIS, IND.—The Board of Public Works will receive bids until Nov. 2 for grading, and for paving with boulders and brick.

KOKOMO, IND.—The City Clerk will receive bids until Nov. 7 for brick sidewalks in several streets.

CANTON, ILL.—Bids are asked until Nov. 1 for 9,900 sq. yds. of brick paving, including curb, sidewalks, etc., the same to be completed by June 1, 1893. W. G. Harte, Cy. Engr.

MINNEAPOLIS, MINN.—The City Engineer has been directed to have several streets paved with cedar blocks.

GREAT FALLS, MONT.—Bids for paving Central Ave., were opened Oct. 17, according to three propositions: (1) Two courses of vitrified brick on concrete; (2) One course of brick on concrete; (3) Cedar blocks on concrete. The bids were as follows: Parker & Armington, (1), $81,900; (2), $65,900; (3), $69,900; McKay Bros., (3), $48,545; Mark Tuck, (3), $46,625; H. B. Palmer, (1), $98,750; (2), $81,150; (3), $60,030; H. Vogel, (1), $57,025; (2), $46,625.

SAN FRANCISCO, CAL.—The Commissioners for the extension of Potrero Ave., report that the total cost of the proposed work will be $241,203.

ELECTRICAL.

RAHWAY, N. J.—We are informed by S. Rusling Ryno, Cy. Clk., that the contract for lighting the streets of the city from Nov. 1 until July 1, 1893, has been awarded to the Rahway Gas Light Co. New proposals will be advertised for during June, 1893. About 300 incandescent lights or 54 arc lights of 2,000 c. p. will be required.

CATONSVILLE, MD.—The Eden Park Land Co. can give information concerning a proposed plant.

STAUNTON, VA.—An electric light plant is to be erected by the City Street Car Co.

TAMPA, FLA.—The Consumers' Electric Light & Street Railway Co. has been organized by E. S. Douglas, M. H. Cohen and others, and will erect a plant for both lighting and power purposes.

WEST POINT, ALA.—An election will soon be held to vote on the issue of bonds for $20,000 for an electric light plant and for water-works.

ALEXANDRIA, LA.—The American Electrical Co., Philadelphia, Pa., will receive bids for the construction of an electric light plant at this place.

HANNIBAL, MO.—The City Clerk will receive bids for a municipal plant. Electric light bonds for $20,000 have been sold.

WACO, TEX.—The City Council is considering a proposition from the Franklin Light Co., Kansas City, Mo., for the erection of a municipal plant.

NEVADA CITY, CAL.—It is reported that private parties are about to erect an electric power plant to cost $500,000.

SACRAMENTO, CAL.—The City Council has granted a franchise to the Folsom Water Power Co. to introduce electricity into the city for lighting and power purposes. The electricity will be generated by water power at Folsom, a distance of 20 miles, and it is claimed that several thousand horse-power will be transmitted to the city.

SANTA CRUZ, CAL.—E. Browne has completed the surveys and estimates upon the water power of the San Lorenzo River, recently acquired by the Santa Cruz Electric Light & Power Co. It is proposed to construct a dam 175 ft. on the crest and 20 ft. in thickness, which will restrain about 7,500,000 cu. ft. of water. About 500 or 600 horse-power will be developed, and the estimated cost is $250,000.

NEW COMPANIES.—Helios Electric Co., Philadelphia, Pa.; $100,000; Treas., John Mustard. Farmington Electric Light & Power Co., Peoria, Ill.; $12,000; E. R. Hillman, L. B. Bradley, H. T. Hays. Keithsburg Electric Light & Power Co., Peoria, Ill.; $15,000; E. B. Hillman, L. B. Bradley, H. T. Hays. Clay Center Electric & Water Power Milling Co.; Clay Center, Kan.; $150,000; A. F. Dexter, P. M. Wickstrum, J. B. Snell, Brooklyn, Kan. Eureka Light & Power Co., Eureka, Kan.; $30,000; J. B. Cloggston, D. B. Fuller, J. B. Pierce.

CONTRACT PRICES.

WATER-WORKS PLANT.—Buckley, Wash.—We are informed by W. P. & A. B. Wood, Engrs., Tacoma, that the contract for a water-works plant has been awarded to P. V. Dwyer & Bros., at $10,800, the work to be completed in 45 days. The other bidders desired 90 days in which to do the work. The bids were as follows: Power & Collins, material f. o. b. in Buckley, furnishing wrought iron, lap-welded, Converse lock-joint and asphaltum coated pipe, 6-in., 6,500 lin. ft., 49 cts. per lin. ft.; 4-in., 2,000 lin. ft., 28 cts.; 3-in., 4,000 lin. ft., 21 cts.; Matheson joint, 6-in., 49 cts.; 4-in., 31 cts.; 3-in., 22 cts.; spiral riveted steel, 6-in., 54 cts.; 4-in., 31 cts.; 3-in., 21 cts.; pumping plant, complete, Dean pump, $2,750; well for supply, $750; tower and tank, $1,875; or plant complete, except 3-in. pipe and fittings, with Dean pump, $10,640, $10,750, or $11,510 for Converse joint, Matheson joint, or spiral riveted pipe, respectively.

North West Supply Co., spiral riveted pipe, 6-in., 54 cts.; 4-in., 31.75 cts.; 3-in., 21.06 cts.; for pumping plant, complete, Gordon pump, $3,157; system complete, except 3-in. pipe and fittings, $12,372 or $14,334, for spiral riveted or Converse joint pipe. Small Bros., tank, $1,875. J. C. Lillis, system complete, $15,688. Hoge & Swift, Matheson joint pipe, 6-in., 49 cts.; 4-in., 29 cts.; 3-in., 21 cts. P. V. Dwyer & Bros., Matheson joint pipe, 6-in., 49 cts.; 4-in., 29 cts.; tank, $1,875; pumping plant complete, Deane pump, $2,750; well, $525; Ludlow gates, 6-in., $16.50, and 4-in., $9.50; Ludlow hydrants, 4-in. connection and 3-ft. stem, $50; special castings, 5.5 cts. per lb.; plant complete, except 3-in. pipe and fittings, with Matheson pipe and Deane pump, $10,809.

The plant will have a Deane pump, capacity 750,000 gallons per 24 hours; boiler, 14 × 8½ × 10 ins., 70 H.P., made by Springfield Boiler Mfg. Co.; Matheson patent lock joint pipe, made by American Tube & Iron Co.; Ludlow gates and hydrants; a redwood tank, 24 × 18 ft., on a tower 52 ft. in height. In case of fire the tank will be cut off, and the pressure used directly from the pump, which will be located 95 ft. below the grade of Main St.

DRAINAGE CANAL.—Chicago, Ill.—The Drainage Board opened bids Oct. 19 for the construction of 8 miles of the main drainage canal, between Willow Springs and Summit. Bids were received on two propositions, one being for a channel of 600,000 cu. ft. capacity per minute, and the second for one of 300,000 per minute, the former requiring the excavation of 11,400,000 cu. yds. of earth, 500,000 cu. yds. of rock, and the building of 40,000 cu. yds. of dry rubble walls, and the second calling for the removal of 7,825,000 yds. of earth, 350,000 cu. yds. of rock, and the same number of yards of wall. There were eight bidders, as follows: C. D. Smith & Co., Baltimore, Md.; Elliott & Phin, Chicago; Mason, Hoge & Cox, Frankfort, Ky.; James T. Dougin, Chicago; Ricker, Lee & Co., Galveston, Tex.; Miller, Loomis & Gill, Chicago; W. S. Cartin, East Saginaw, Mich.; McArthur Bros., Chicago.

The work was divided into six sections, and bids invited upon each one separately on both propositions. On the first three sections, McArthur Bros. were the lowest bidders, and on the last three, Ricker, Lee & Co. Their bids were as follows:

Proposition No. 1.—McArthur Bros.: Section A, $1,033,516; B, $598,572; C, $691,968. Ricker, Lee & Co.: Section D, $372,095.50; E, $476,519.25; F, $470,040.

Proposition No. 2.—McArthur Bros.: Section A, $816,647; B, $426,894. Ricker, Lee & Co., Section D, $260,775; E, $346,499; F, $366,860.

Under proposition 1, the total cost is $3,642,811.75; under No. 2, $2,705,711, showing a balance of $937,000 in favor of the channel.

The price per cubic yard of excavation ranged higher than that which the Board is now paying for excavations. This is due to the fact that there is a longer haul on this part of the work, and also to a clause in the contract which requires the completion of a levee for the diversion of the flood waters of the Des Plaines River before March 1 next. The latter is, doubtless, responsible also for the small number of bids, a number of contractors refusing to bid at all for the work because of it.

The bids ranged from that of W. E. Carten, 58 cts. per cu. yd. for earth, to that of Ricker, Lee & Co., 20½ cts.; and on rock excavations from $3 per cu. yd., bid by W. S. Cartin, to 70 cts., by McArthur Bros. The latter firm was the only one which put in a bid for every section under each proposition. The bids received for the construction of the canal between Willow Springs and Joliet were printed in our issues of June 16 and 30.

PIPE.—St. Louis, Mo.—The lowest bid received by the Water Board for furnishing and delivering at Bissell's Point 685 tons of 36-in. cast iron, coated pipe; 5 tons of 12-in. pipe, and 35 tons of special castings, was that of the Howard-Harrison Iron Co., Bessemer, Ala., $25.48 per ton for pipe, and $60 per ton for special castings.

SEWERS.—Denver, Colo.—The lowest bid for the Downing Ave. sewer was that of J. B. Hendry, as follows: 8-in. vitrified pipe, 10,000 lin. ft., 55 cts. per lin. ft.; 10-in., 700 ft., 70 cts.; 15-in., 1,150 ft., 90 cts.; 8 × 6 ins. branches, 100, 55 cts.; 10 × 6 ins., 50, 70 cts.; manholes, $45 each.

Utica, N. Y.—The Council has favorably considered bids for pipe sewers in five streets. The lowest prices ranged as follows: 15-in., $1.13 to $1.40 per lin. ft.; 12-in., 60 cts.; 15-in. branches, 94 cts. to $1.25 per lin. ft.; 12-in., 93 cts.; 9-in. catch basin branches, 50 to 75 cts.; 6-in. house connections, 45 cts.; manholes, $40 to $45 each; catch basins, $33 to $39; timber in foundations, $13 to $15 per 1,000 ft. B. M.; rubble masonry, $1.50 to $3 per cu. yd.; concrete, $1.50 to $3.

CRIB-BULKHEAD, TIMBER, ETC.—New York, N. Y.—The Department of Docks will receive bids until Nov. 3 for the following work: Building a crib-bulkhead from West 129th to 130th Sts., North River, the work to include about 150,800 cu. ft. of crib work, complete, with white oak fender-pile 45 ft. long, etc., and 3,000 cu. yds. dredging; furnishing 1,698,598 ft. B. M. of sawed yellow pine timber, size from 4 × 10 ins. to 12 × 14 ins., and length from 6 ft. 9 ins. to 35 ft. 6 ins.; also for two cast iron drain boxes, with pipes, foundations, etc., 600 cu. yds. sand or gravel, 1,800 sq. yds. paving, etc.

LEVEE IMPROVEMENT.—Sacramento, Cal.—At a special election Oct. 13, the citizens voted almost unanimously to issue the proposed $100,000 bonds for a comprehensive plan of levee improvements. The city is reported as not having been in danger from a flood at any time within 30 years, but the contemplated improvement is intended to provide against future emergency.

TIES.—Moncton, N. B.—The Intercolonial Railway will receive bids until Nov. 8 for a supply of ties. D. Pottinger, Ch. Supt.

BREAKWATER.—Ottawa, Ont.—The Department of Public Works will receive bids until Nov. 8 for a breakwater at Point du Caene, Westmoreland, Co., N. B.

GAS COMPANY.—Chicago, Ill.—The Chicago West Division Gas Co. has been incorporated by Chas. D. Hank, August Lueder and LeGrand W. Pierce; capital stock, $2,000,000.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Pittsburg Locomotive Works, Pittsburg, Pa., have an order for three switch engines for the Biwabik Ore Co., Duluth, Minn. The Rogers Locomotive & Machine Works, Paterson, N. J., are building two suburban tank engines, one compound and one simple, for the Illinois Central; they have six coupled wheels. The Baldwin Locomotive Works, Philadelphia, Pa., have built three simple and two Vauclain four-cylinder compound locomotives for the Atlantic Coast Line.

CARS.—The Madison Car Co., Madison, Wis., has an order for 500 box cars for the Wabash. The Roanoke Machine Works, Roanoke, Va., are building 250 freight cars for the Pennsylvania. The Duluth Mfg. Co., Duluth, Minn., has an order for 700 ore cars for the Duluth, Mesaba & Northern. The Jackson & Sharpe Co., Wilmington, Del., is building 2 baggage cars, 2 combination smoking cars, 4 passenger cars and 2 parlor cars for the Jacksonville, St. Augustine & Indian River; the company is also building 6 passenger cars for the Ohio Valley. The Michigan & Peninsular Car Co., Detroit, Mich., has an order for 600 box cars for the Lake Shore & Michigan Southern. The Atlantic Coast Line is building 300 freight cars at its shops at Wilmington, N. C.

CAR WORKS.—The Ohio Falls Car Mfg. Co., of Clarksville, near Jeffersonville, Ind., has been incorporated as successor to the Ohio Falls Car Co., which was established in 1865. The new company has a capital stock of $1,800,000. Pres., J. L. Smyser; Vice-Pres. and Gen. Man., M. E. Duncan; Secy. and Treas., J. D. Stewart. The new company has acquired and taken over the property and business of the old company for the manufacture of passenger, parlor and freight cars of every description. The company owns about 62 acres of land in Clarksville, immediately adjoining Jeffersonville, Ind., a city of some 13,000 inhabitants, directly opposite Louisville, Ky. There are 70 buildings, 51 of which are built of stone and brick with iron and slate roofs. They are of the most substantial character and uniform architecture, and especially constructed for the requirements of the business. The machinery is of the most approved type and is maintained in a high state of efficiency. The capacity of the works is 5 passenger cars per week and 25 freight cars per day, employing 1,500 to 2,000 men, with an annual output approaching $3,000,000 in value. A very complete fire system protects the property by means of hydrants and automatic sprinklers, connecting with the public waterworks of Jeffersonville.

CAR WHEELS.—The Buffalo Car Wheel Foundry Co., Buffalo, N. Y., has purchased a site for extensive works, which will have a capacity of 500 wheels per day. The works will probably be completed in three months. Geo. W. Miller, President of the Buffalo Car Mfg. Co. is interested.

RAILWAY SHOPS.—The Susquehanna & Western has nearly completed its new shops at North Paterson, N. J. They include a machine shop, 220 × 81 ft.; blacksmith shop, 90 × 51 ft.; tank shop, 63 × 30 ft.; engine house, 40 × 31 ft., and a car repair and paint shop, 140 × 81 ft. All the buildings are of brick. They will be put in operation shortly with a force of about 400 men.

CEMENT WORKS.—A new cement manufacturing plant is now being built in the town of Rosendale, N. Y. Mr. William M. Hoag, the president of the company, has been at Kingston superintending the erection of the works. He is reported as saying that 30 kilns for the burning of the stone, with other suitable machinery, are to be built. Permanent employment to about 400 men is to be given, and it is expected to turn out 3,000 barrels of cement a day.

CREOSOTE WORKS.—The Galveston Wharf Co.'s creosoting works at Galveston, Tex., were burned Oct. 11. They were erected by the wharf company a little over a year ago at a cost of $75,000. They were completely equipped and contained a creosoting tank of 250,000 gallons capacity, besides 600,000 barrels of creosote oil, and were used exclusively by the wharf company in creosoting material used in constructing and repairing their wharves. According to report, Mr. J. M. Brown, President of the company, estimates that the damage can be repaired for $10,000 or $12,000.

NEW COMPANIES.—Railway Safety Signal Co., Newark, N. J.; $500,000; I. Wayland and W. A. Mott, of Newark; J. W. Smith, of Bernardsville, N. J. Dearborn Power Co., Chicago, Ill.; $20,000; A. T. Dexter, G. B. Nelsen and H. M. Smith. Abingdon Paving Brick & Tile Co., Abingdon, Ill.; $8,000; J. T. Latimer and Mm. Lutz. Brule River Improvement Co., Brule, Wis.; $5,000; Bernard Doherty and George T. Merrill.

CURRENT PRICES.

RAILS.—New York: $30 at eastern mills, $30.75 at tidewater; old rails, $16.50 to $17 for iron and $14 to $14.50 for steel. Pittsburg: $30; old rails, $19.50 to $20 for iron and $15 to $16 for steel. Chicago: $31 to $32.50; light rails, $32; old rails, $18.50 for iron, and $12.50 to $14.25 for steel.

TRACK MATERIAL.—New York: steel angle bars, 1.6 to 1.65 cts.; spikes, 1.9 to 2 cts.; track bolts, 2.4 to 2.6 cts. with square and 2.7 to 2.8 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.77 cts. for iron and 1.8 cts. for steel; iron and steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.7 to 1.75 cts. for iron and steel; spikes 2.05 to 2.1 cts.; track bolts, 2.6 to 2.7 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows at Pittsburg: 57½% and 10% and 50 and 10% on black and galvanized butt-welded; 67% and 10%, and 60% and 10% on black and galvanized lap-welded. Casing, 55%.

FOUNDRY PIG IRON.—New York: $13.50 to $16. Pittsburg: $13 to $14.25. Chicago: $13.25 to $14.75.

LEAD.—New York: 3.95 to 4 cts.; Chicago: 3.9 to 3.95 cts.; St. Louis: 3.7 to 3.75 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.2 to 2.5 cts. for large lots, and 2.35 to 2.75 cts. for small lots; channels, 2.25 to 2.5 cts.; angles, 1.95 to 2 cts.; tees, 2.3 to 2.75 cts.; sheared iron plates, 1.85 to 2.1 cts.; steel plates, 1.9 to 2 cts. for tank, 2.2 to 2.25 cts. for shell, 2.5 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 2.05 to 2.1 cts. for large lots; channels, 2.05 to 2.1 cts. for large lots; angles, 1.8 to 1.9 cts.; tees, 2.4 to 2.5 cts.; Z-bars, 2 to 2.1 cts.; universal mill plates, 1.75 to 1.8 cts. for steel; sheared steel bridge plates, 2 to 2.1 cts.; refined bars, 1.7 cts. for iron and steel; steel plates, 1.75 to 2 cts. for tank, 2 to 2.25 cts. for shell, 2 to 2.25 cts. for flange, 3.5 to 3.75 cts. for firebox, 2 to 2.15 for bridge. Chicago: beams, 2.15 to 2.5 cts.; channels, 2.25 to 2.3 cts.; angles, 2 to 2.25 cts.; tees, 2.25 to 2.4 cts.; universal plates, 2 to 2.2 cts.; steel plates, 2 to 2.1 cts. for tank, 2.15 to 2.25 cts. for shell, and 2.3 to 2.7 cts. for flange.